Lincoln Park Public Schools – CURRICULUM FRAMEWORK
UNIT NUMBER: #6 (Semester 2, Unit 2)
UNIT TITLE: Chemical Quantities
Course: Chemistry Grade: 11 Timeframe: 20 periods (4 weeks)

Stage 1: Identify Desired Results	
Essential Question:	How are stoichiometry and the mole related to the production of everyday substances? Why are these concepts vital to understanding the chemistry of our world?
Scaffold Questions:	● What is a mole? ● How do chemists use a mole to count in chemistry? ● How many moles are in everyday items? ● How do we really know how many particles in a mole? ● What happens if we have more or less than one mole? ● How does chemistry use its unique counting system for everyday atoms and molecules in my life? ● When looking at the chemical formula NaCl, for example, does that mean just one Na and one Cl? If yes, then how come I can see salt when I can't see at atom? ● Can I use this chemical counting system to determine chemical formulas? ● Once we are familiar with the meaning of a chemical formula, how can we use this information to build an understanding of a balanced chemical equation? ● What is the meaning of a balanced chemical reaction? ● If we know that a balanced chemical equation represents a mole to mole ratio, how can we use that information to predict the amount of product produced in a chemical reaction? ● Can I use a balanced chemical equation to predict how much of a product will produced in a chemical reaction? ● What are some useful applications of stoichiometry?

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	• How is stoichiometry used to design something like an airbag? • Do some reactions give off heat while others need heat? How can this be measured? • How do you quantify energy in a chemical reaction? • Other than the amount of heat, what other quantities can be calculated from a neutralization reaction? • What is a titration and how is it useful? • How is knowing the concentration of a solution useful? • Would a more concentrated acid or base produce more energy? • Can stoichiometry be used to determine the amount of energy from a chemical reaction?
Brief Summary of Unit:	The purpose of this unit is to guide students' understanding of chemistry as a quantitative science. The beginning of the unit introduces the mole. This chemistry method of counting means that 1 mole of "anything" is equal to a 6.022×10^{23} "items" and has a molar mass equal to the mass on the periodic table. The chemical mole is the concept that connects writing formulas, balancing chemical equations, stoichiometry, and heat of reactions, and each of these concepts is explored as this unit progresses. At the end of this unit, students will complete a performance task in which they will determine the correct ratio of baking soda and vinegar to produce the most carbon dioxide possible.
Desired Understanding:	Stoichiometry and chemical quantities are at the heart of the production of many things you use in your daily life. Soap, tires, fertilizer, gasoline, deodorant, and chocolate bars are a few commodities you use that are chemically engineered, or produced through chemical reactions. Just like the perfect cake requires very specific amounts of each ingredient, all products of chemical reactions rely on specific chemical quantities to be properly functional. Because the scale of chemical reactions is too small to truly grasp, concepts like stoichiometry allow us to have a more concrete grasp on everyday substances and reactions.

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Key Knowledge and Skills (Content):	**The following is a list of "I Can" statements that will be used throughout this unit:** • I CAN ask questions that arise from examining models or a theory, to clarify and/or seek additional information and relationships. • I CAN ask questions to determine relationships, including quantitative relationships, between independent and dependent variables. • I CAN use math and computational thinking to create and/or revise a computational model or simulation of a phenomenon, designed device, process, or system. • I CAN develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems. • I CAN use mathematical, computational, and/or algorithmic representations of phenomena. • I CAN apply techniques of algebra and functions to represent and solve scientific problems. • I CAN construct explanations to apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena. • I CAN apply ratios, rates, percentages, and unit conversions in the context of complicated measurement problems. • I CAN define a design problem that involves the development of a process or system with interacting components and criteria and constraints that may include social, technical and/or environmental considerations. • I CAN plan an investigation or test a design individually and collaboratively to produce data to serve as the basis for evidence as part of building and revising models, supporting explanations for phenomena, or testing solutions to problems.

	• I CAN communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, mathematically). • I CAN analyze data to evaluate the impact of new data on a working explanation and/or model of a proposed process or system. • I CAN recognize the mass of a sample is the mass associated with that element of the periodic table (atomic mass). • I CAN recognize that in everyday samples there are more atoms and molecules than chemists can even begin to count so relying on calculations to determine moles/quantity of atoms is important to chemistry. • I CAN distinguish the number of mass, mole and molecules in a sample. • I CAN define and compute molar mass. • I CAN explain that a chemical formula also represents the ratio of moles that are needed to make that compound. • I CAN describe and predict chemical reactions using my knowledge of the fact that atoms are conserved and my knowledge of the chemical properties of the elements involved • I CAN explain that chemical reactions take place on a mole to mole ratio and that in these chemical reactions, mass is conserved. • I CAN use stoichiometry to predict the amount of reactants needed for the chemical reaction to produce enough gas to fill an airbag • I CAN apply what I know about energy as it relates to chemical processes when conducting a scientific inquiry. • I CAN quantify the amount of energy given off during a reaction.

	• I CAN explain why, in a chemical reaction, one must provide at least this energy in order to take the molecule apart, and that energy will be released when a bond is formed. • I CAN use the law of conservation of energy to explain that the total change of energy in any system is always equal to the total energy transferred into or out of the system, and that while energy cannot be created or destroyed, it can be transported from one place to another and transferred between systems or converted to less useful forms. • I CAN distinguish between endothermic and exothermic chemical reactions • I CAN describe what happens during a neutralization reaction where there are equal number of acid and base moles and discuss how this information is used calculated concentration which is the moles of solute for each liter of solution The following link is a teacher guide for this unit. There are links available for use and descriptors of activities and lessons: https://docs.google.com/document/d/1NMygaZtGkaqqxehnlcEASw-Xus8gMwlvuBlJvee2D9U/edit?usp=sharing

Next Generation Science Standards (NGSS)	**Targeted NGSS Performance Expectation(s)**
	• HS-PS1-4.
	  ○ Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.
	• HS-PS3-1.
	  ○ Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component and energy flow in and out of the system are known.
	• HS-PS3-4.

	○ Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system. ● HS-PS1-7. ○ Use mathematical representation to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. **Targeted Disciplinary Core Idea(s)** ● PS1.A: Structure and Properties of Matter ○ A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart. (HS-PS1-4) ○ An exothermic reaction has stronger bonds in the product producing more energy than was required to break the bonds of the reactants an endothermic reaction has stronger bond in the reactants required more energy to break the bonds than was produced in forming the bond of the product ● PS1.B: Chemical Reactions ○ Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy. (HS-PS1-4) ○ The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. (HS-PS1-7) ● PS3.A: Definitions of Energy

	◦ Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. (HS-PS3-1) - PS3.B: Conservation of Energy and Energy Transfer - Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. (HS-PS3-1) - Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PS3-1),(HS-PS3-4) - PS3.D: Energy in Chemical Processes - Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment. (HS-PS3-3),(HS-PS3-4) **Targeted Cross-Cutting Concepts** - Patterns - In grades 9-12, students observe patterns in systems at different scales and cite patterns as empirical evidence for causality in supporting their explanations of phenomena. They recognize classifications or explanations used at one scale may not be useful or need revision using a different scale; thus requiring improved investigations and experiments. They use mathematical representations to identify certain patterns and analyze patterns of performance in order to reengineer and improve a designed system. - Scale, Proportion and Quantity - In grades 9-12, students understand the significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. They recognize patterns observable at one scale may

	not be observable or exist at other scales, and some systems can only be studied indirectly as they are too small, too large, too fast, or too slow to observe directly. Students use orders of magnitude to understand how a model at one scale relates to a model at another scale. They use algebraic thinking to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).
	• Energy and Matter
	  ○ In grades 9-12, students can investigate or analyze a system by defining its boundaries and initial conditions, as well as its inputs and outputs. They can use models (e.g., physical, mathematical, computer models) to simulate the flow of energy, matter, and interactions within and between systems at different scales. They can also use models and simulations to predict the behavior of a system, and recognize that these predictions have limited precision and reliability due to the assumptions and approximations inherent in the models. They can also design systems to do specific tasks.
	Targeted Scientific Practices
	• Using Mathematics and Computational Thinking
	  ○ Mathematical and computational thinking in 9- 12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions
	    ■ Apply techniques of algebra and functions to represent and solve scientific and engineering problems.

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	■ Apply ratios, rates, percentages, and unit conversions in the context of complicated measurement problems involving quantities with derived or compound units
Common Core State Standards (CCSS) - ELA	• **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) • **RST.11-12.1** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-PS1-3),(HS-PS1-5) • **WHST.9-12.2** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-PS1- 2),(HS-PS1-5) • **WHST.9-12.5** Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (HS-PS1-2) • **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. (HSPS1-3),(HS-PS1-6) • **WHST.11-12.8** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-PS1-3)

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	• **WHST.9-12.9** Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS1-3) • **SL.11-12.5** Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-PS1-4)
Common Core State Standards (CCSS) - Mathematics	• **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. (HS-PS1-2),(HS-PS1-3),(HS-PS1-4),(HS-PS1-5),(HS-PS1-7),(HS-PS1-8) • **HSN-Q.A.2** Define appropriate quantities for the purpose of descriptive modeling. (HS-PS1-4),(HS-PS1-7),(HS-PS1-8) • **HSN-Q.A.3** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS1-2),(HS-PS1-3),(HS-PS1-4),(HS-PS1-5),(HS-PS1- 7),(HS-PS1-8)
Alignment to the Vision of High Quality Instruction in Science	• Teachers anchoring their instruction in complex and puzzling natural events • Students engaging in multiple rounds of creating and revising scientific models, explanations and evidence-based arguments • Students prompting each other to engage in sense-making talk during investigations and other activities • Students' ideas being represented publicly and worked on by the class

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Stage 2: Determine Acceptable Evidence (With the exception of formative assessments, all assessments listed in this section are required elements of the district's curriculum and the data associated will be collected in the district's performance management driver system.)	
Measure of Understanding (Performance Task)	Where did the CO_2 go? HS-PS1-4, 1-7, 3-1, 3-4 **Scenario:** The Insta Cold Dry Ice company needs a new source of Carbon dioxide and has asked their lead chemists to determine a chemical reaction as a source for them. You and your team will need to determine the exact ratios of reactants to produce the desired yield. During the Day 1 experiments, you did not produce the expected amount of Carbon dioxide. One of the reactants is a limiting factor to the reaction. With your group your task is to design an experiment to determine the correct concentration of reactants to produce the amount of Carbon dioxide you expected and to determine which reactant was the limiting factor. Task: Produce a poster that demonstrates your learning and understanding of your day 2 and 3 activity. Your poster will be presented to the CEO of the Insta Cold Dry Ice Company to help her determine a new source of CO_2. It should include: ● Detailed explanation of the experiments completed in the process to determine the required reactants. ● Analysis of data from experiments

	• Account for matter (atoms/mass before and after reaction using moles) • Explanation of application of the Le Chatelier Principle. • Analysis of the priority of criteria (trade-offs) needed to determine the optimum concentrations vs waste product to produce the optimum CO_2 level.
Assessing the Performance Task	Rubric is included in the Performance Task Document
Summative Assessment	Unit 6 Test HS-PS1-4, 1-7, 3-1, 3-4
Interim Assessments	Mole quiz Empirical formula quiz Stoich quiz
Formative Assessments	Individual and small group conferences Lab observations Exit tickets/DoNow

	Daily/weekly ISN checks Homework assignments
Student Self-Reflection and Self-Regulation **(Student-Centered)**	Students will have a few different ways to reflect and assess personal and group progress. Because this unit has continual small group assignments, they will use the collaboration and group work rubrics more than once throughout the unit. • Collaboration Rubric • Group and Self Assessment Tool • Unit Reflection Form
State Assessment Practice	MSTEP style questions