Madison Public Schools

Chemistry - Unit 4 - The Mole, Chemical Reactions and Stoichiometry

Unit Focus

In Unit 4, the previous learnings of Units 1 through 3 are brought together in an integrated level of conceptual understanding as students begin an in depth look at chemical quantities, chemical reactions and the importance of both topics to the quantitative understanding of chemical reactions. Students will apply the fundamental concept of the 'mole' in order to count particles using the mass of a sample. Based on the mole concept, students will be able to determine the percent composition of a substance and deduce the empirical and molecular formula of an unknown compound. Ultimately, students will balance chemical equations and analyze the amounts of reactant and products involved in a chemical reaction. Students will apply these learnings in an inquiry style lab where the student will use an experimental mole ratio to determine the balanced chemical reaction that occurred.

Stage 1: Desired Results - Key Understandings

Standard(s)

Next Generation Science
High School Physical Sciences: 9 - 12

- Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. *HS-PS1-7*

Next Generation Science Standards (DCI)
Science: 11

- 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. *PS1.9.B1*
- 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. *PS1.9.B3*

NGSS/NSTA Science & Engineering Practices
NGSS Science & Engineering Practices: 9-12

- Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. *SE.9-12.4.1*

Transfer

T1 Analyze qualitative and quantitative data to interpret patterns, draw conclusions, and/or make predictions.
T2 Model relationships among quantities.
T3 Make sense of a problem, initiate a plan, execute it, and evaluate the reasonableness of the solution.
T4 Apply familiar mathematical concepts to a new problem or apply a new concept to rework a familiar problem.

Meaning

Understanding(s)	Essential Question(s)
U1 The mole provides a direct relation between the observable macroscopic properties and the submicroscopic atoms that are not visible. **U2** Chemical processes, their rates, and corresponding energy changes can be understood in terms of the collisions of molecules and the rearrangement of atoms as bonds break and form to create new molecules **U3** The fact that atoms are conserved can be used to describe and predict chemical reactions. **U4** Chemists understand that placing a reaction in a category allows one to predict products and quantities. **U5** Effective problem solvers work to make sense of the problem before trying to solve it.	**Q1** How can we measure what we can't see? **Q2** What happens to atoms and energy in a chemical reaction? **Q3** How does one characterize, explain, and quantify chemical reactions and make predictions about them?

Stage 1: Desired Results - Key Understandings

- Apply ratios, rates, percentages, and unit conversions in the context of complicated measurement problems involving quantities with derived or compound units (such as mg/mL, kg/m3, acre-feet, etc.). *SE.9-12.5.6*
- Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion. *SE.9-12.6.4*
- Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. *SE.9-12.6.5*

Student Growth and Development 21st Century Capacities Matrix

Critical Thinking

- Analyzing: Students will be able to examine information/data/evidence to make inferences and identify possible underlying assumptions, patterns, and relationships. *MM.1.2*
- Synthesizing: Students will be able to thoughtfully combine information/data/evidence, concepts, texts, and disciplines to draw conclusions, create solutions, and/or verify generalizations for a given purpose. *MM.1.3*

Acquisition of Knowledge and Skill

Knowledge	Skill(s)
K1 One mole of a substance contains Avogadro's number of particles and has a mass equal to the atomic mass of the element on the Periodic Table, in grams. **K2** Chemical formula describes the ratio of elements in a compound. **K3** The metal activity series, and independently the nonmetal activity series, allow for determination that a single displacement reaction will or will not occur **K4** The solubility rules enable us to predict which substances will form precipitates when combined in aqueous solution. **K5** A limiting reactant dictates the outcome of a chemical reaction. **K6** Excess reactant will always exist in a leftover amount when the reaction is completed.	**S1** Make conversions among particles, mass, and moles of any substance **S2** Calculate percent composition of compounds and determine empirical and molecular formulas **S3** Write a complete and balanced equation, given only the reactants, by name. **S4** Assess whether a reaction will occur by referring to an activity series. **S5** Predict precipitates by referring to solubility rules. **S6** Use dimensional analysis to calculate amounts of reactants and products including limiting and excess reagents.