MOLAR RATIO

Performance Standard 12 C/11A.J

Students will apply the concepts, principles and process of scientific inquiry to explain chemical bonding and reactions accordingly:

- *Knowledge:* Identify the chemical products produced from the reaction and the theoretical molar ratio between reactants.
- *Application:* Analyze the mass of the reactants and products to find the molar ratio, comparing the experimental to the theoretical molar ratios and using statistical analysis of percent (%) error to help support or refute hypothesis.
- *Communication:* Write a lab report expressing an analysis of findings including: question, hypothesis, rationale, data, calculations, and conclusion summary.

Procedure:

1. ***In order to know and apply concepts that describe properties of matter and energy and the interactions between them (12C), and the concepts, principles and processes of scientific inquiry (11A), and apply the accepted practices of science (13A),*** students should experience sufficient learning opportunities to develop the following:
   - Formulate a hypothesis by referencing prior knowledge of balancing chemical equations and the relationship to number of moles.
   - Identify the reactants and products and project balanced equation proportions.
   - Incorporate all procedural and safety precautions, materials, and equipment handling directions and data-collection formatting preparations.
   - Quantify reaction masses (reactants and products) with appropriate technologies.
   - Interpret and represent analysis of results to produce findings associated with input and output calculations and molar ratios to determine if data supports or refutes hypothesis.
   - Evaluate data sets to explore explanations of outliers, or sources of error, applying statistical methods to compare percent error.
   - Report, display and defend the findings by critiquing, presenting and defending the final report by peer review.
   - Explain how the experimental molar ratio compares to the theoretical molar ratio and impact of possible sources of error.

   Note to teacher: This activity relates to knowledge associated with standard 12C, while addressing the performance descriptors for stage J within standard 11A and 13A. This activity could be incorporated directly in a curricular study on writing formula, balancing equations and calculating number of moles from mass of reactants or products.
2. Have students review and discuss the assessment task and how the rubric will be used to evaluate their work.
3. Provide each student with a copy of the Molar Ratio student instruction/task sheet and review lab report write-up requirements. Supply the students with the listed materials, emphasizing safety in the use of hydrochloric acid and heating source.
4. Evaluate each student's work using the Science Rubric as follows and add the scores to determine the performance level:
   - *Knowledge:* The hypothesis statement and rationale was complete and expressed a correct understanding of formula writing and balancing equations.
   - Application*:* The data table was neat and organized, while the values expressed showed correct application of precision and accuracy. Calculations were correct and complete.
   - *Communication:* The conclusion summary was well-organized, well-detailed, and thoroughly explained the analysis of the hypothesis, explanation of outliers, sources of error and their impact, and a reflection of their peer critiques.

Examples of Student Work not available

Time Requirements

- Two class periods

Resources

- Molar Ratio Instruction/Task Sheet
- Science Rubric
- Sodium Bicarbonate
- 3M Hydrochloric acid
- Micropipettes
- Evaporating dish
- Electronic balance
- Heating source (Bunsen Burner or Hot Plate)
- Goggles

MOTOR RATIO INSTRUCTIONS

For this activity, you are asked to react sodium bicarbonate with hydrochloric acid to determine the molar ratio between the two reactants. Using the given procedure address the following question by writing an appropriate hypothesis giving a rationale that explains how you arrived at the hypothesis statement. For the rationale, you will need to write correct formula and balance the chemical equation, explaining how these relate to your hypothesis. Come prepared with your hypothesis, rationale and an organized and neatly constructed data table before the next class period.

Investigation Question: What is the molar ratio of sodium bicarbonate to sodium chloride in the reaction between sodium bicarbonate and hydrochloric acid?

Hypothesis:

Rationale:

Materials:
Sodium bicarbonate
3-M Hydrochloric acid
Micropipettes
Evaporating dish
Electronic balance
Heat source
Goggles

Procedure:

1. Put on your goggles and apron.
2. Mass the empty evaporating dish.
3. Put from 0.25-0.50 grams of Sodium bicarbonate into the evaporating dish.
4. Add Hydrochloric acid a drop at a time, listening and watching the reaction. Continue adding Hydrochloric acid until the reaction stops.
5. Evaporate the liquid from the evaporating dish by gently heating it with a heat source until dry.
6. Repeat the procedures in 2-5 twice more, for a total of three trials.
7. Technique suggestions include:
    - As hydrochloric acid is added, swirl contents in the evaporating dish.
    - Make sure the product is dry by re-massing the material until the mass is equivalent to previous mass.
    - After visible moisture is evaporated, lower heat to avoid splattering.

Calculations:

Show calculations for mass of sodium bicarbonate and sodium chloride, conversion to moles of sodium bicarbonate and sodium chloride, and molar ratio between them. Calculate theoretical yield based on your balanced equation and determine % error and/or % yield.

Data Table: Create appropriate data table with necessary variables on additional page. Record qualitative observations.

Conclusion:

Write a conclusion summary that incorporates the question, hypothesis, summary of findings, analysis of hypothesis, explanation of outliers, sources of error and their impact, reflection on peer critiques.