Lesson: Stoichiometry of Air Bags

FOR THE TEACHER

Summary
In this lesson, students will be introduced to the concept of gram to gram stoichiometry calculations. Students will be guided through a scenario regarding air bags and will be tasked with calculating the amount of gas (NaN₃) that must be used to inflate a vehicle air bag to the correct size. Follow-up practice problems are also provided.

Grade Level
High School

Objectives
By the end of this lesson, students should be able to
• Appropriately use a mole to mole ratio from a balanced equation in a calculation
• Calculate grams of a reactant or product given grams of a product or reactant

Chemistry Topics
This lesson supports students’ understanding of
• Stoichiometry
• Chemical reactions
• Balancing reactions
• Mole to mole ratios
• Dimensional analysis

Time
Teacher Preparation: 10 minutes
Lesson: 20-30 minutes

Materials
• Power point (teacher use only)
• White board or butcher paper for each pair/group of students
• Calculator
• Periodic table

Safety
• No specific safety precautions need to be observed for this activity.

Teacher Notes
• Prerequisite to lesson: student will need to be able to write and balance chemical equations and also have been introduced to mole to mole stoichiometry or mole to gram stoichiometry calculations.
• Teacher should pre plan how students will be grouped
• Use the PPT to engage the students in the real-life need for this stoichiometry problem, as well as to guide them through the process of solving mass-mass stoichiometry.
• Answers to the air bag stoichiometry problem and the rocket fuel problem are in the power point.
• Answers to individual practice problems are available as a download.
• To continue on the theme of air bag stoichiometry, the following lab from the AACT resources library would be suggested: Air Bag Stoichiometry Lab

FOR THE STUDENT

Lesson

Air Bag Stoichiometry

Background

• Stoichiometry
  ○ mass relationships between substances in a chemical reaction
  ○ based on the mole ratio

• Mole Ratio
  ○ indicated by coefficients in a balanced equation

Prelab Questions
1) Have you ever had an experience with a vehicular air bag? Do you know someone who has?

2) Why would an air bag need to be inflated with an exact amount of gas?

3) What might happen if an air bag was inflated with too little gas?

4) What might happen if an air bag was inflated with too much gas?

Materials
• calculator
• periodic table

Problem
If exactly 59.6g of nitrogen gas is needed to inflate your air bag to the correct size, how many grams of NaN₃ would you need to decompose? (Chemical reaction must be written and balanced first)
**Extension**
The compound diborane (B₂H₆) was at one time considered for use as a rocket fuel. How many grams of liquid oxygen would a rocket have to carry to burn 10 kg of diborane completely? (The products are B₂O₃ and H₂O).

**Individual practice problems**
1. You want to help your little brother make an exploding volcano for his science class. The lava will be made from reacting baking soda (NaHCO₃) with vinegar (HC₂H₃O₂). After building the volcano, you know that you want to create about 100.0g of lava (or sodium acetate). Too little lava, and the volcano won’t overflow. Too much lava would be a giant mess! Using stoichiometry and the equation below, calculate the exact amount of baking soda needed to make 100.0g of lava. Assume you have excess vinegar.

   \[
   \text{NaHCO}_3 + \text{HC}_2\text{H}_3\text{O}_2 \rightarrow \text{NaC}_2\text{H}_3\text{O}_2 + \text{H}_2\text{O} + \text{CO}_2
   \]

2. Camels store the fat tristearin (C₅₇H₁₁₀O₆) in the hump. As well as being a source of energy, the fat is a source of water, because when it is used the reaction below takes place. What mass of water can be made from 1.0kg of fat?

   \[
   2 \text{C}_{57}\text{H}_{110}\text{O}_6 + 163 \text{O}_2 \rightarrow 114 \text{CO}_2 + 110 \text{H}_2\text{O}
   \]

3. You want to create 12g of copper to meld into a piece of jewelry. You know that when copper (II) chloride reacts with aluminum, copper is a product. How much aluminum would you need to start your reaction with to get 12g of copper? (write and balance the reaction first)