**Lesson Plan**

**Teacher: Holland Sloan**

**Subject: Chemistry**

**Lesson: Ideal Gas Law**

**Standards:** CHEM1.PS1. 6. Use the ideal gas law, PV=nRT, to algebraically evaluate the following: number of moles, volume, pressure, and temperature for an ideal gas.

SEP: Defining problems

CCC: System and System Models

DCI: Matter and its Interactions: Structure and properties of Matter

**Objectives:** Student will define problems as they use the ideal gas law to design an airbag model, highlighting system and system models.

**Materials and Resources:** The students will be completing a hands-on activity by building models of an airbag to help them visualize the real-life usage of the ideal gas law. Each group/partnership will need the following materials to complete the lab:

* # re-sealable bags (quart or sandwich size)
* # re-sealable bags (gallon size)
* 1 Molar HCl (1 L per class)
* baking soda
* graduated cylinder
* spatula
* weigh boats or weighing container

**Student Handout:**

<https://docs.google.com/document/d/1dG3FtdHGA8rBcx_OqJWlOiGHMeRm7acT-E8yb7zxeyE/edit>

**Instructional Procedure:**

Beginning: Present the following videos to students: <https://www.youtube.com/watch?v=KuRhYmMb-lg>

After showing the video, write the following equation of the board: 2NaN3 2Na + 3N2.

Then ask students to share some factors that engineers must consider when designing a safe and effective airbag in an automobile. Have students share things they believe airbags need to do to be effective and also limitations of airbags.

Middle: After passing out student activity, students will begin creating their own airbag test based on different ingredients. The chemical reaction is listed on the student handout. Students will begin by balancing the chemical reaction. Based on reactants and products, students will determine five things that they need to know in order to successfully inflate the airbag. Instruct students that they will use the ideal gas law along with the chemical reaction in the design of their airbag. Instruct students to discuss with their groups the variables within the system and how these variables work together in order to ensure that the airbag functions properly.   
Students should discuss important criteria concerning the following: the pressure in the room, the temperature, volume of plastic bag, mass of baking soda, and the volume of hydrochloric acid. Students will have to do several conversions to accurately use the ideal gas law. After discussion, students will then be able to state step-by-step procedures by using the guided design questions for the creation of their model airbag. Students will need to show any necessary calculations. At this point, if teacher has not taught molarity, additional instruction may be needed to determine mole value. Teacher should set parameters for the amount of baking soda and hydrochloric acid to use.

End/Closure: After teacher has approved design model, students are allowed to test their airbags. Students should determine if their airbag was successful or not and why or why not? If not, what improvements could be made to your procedure in order to make it successful next time? Bring the classroom back together and have a discussion as a whole on how the experiment went. Discussions will vary according to how the experiment was conducted. Most students forget that the bags need to be closed before preforming the experiment; therefore, all the pressure is released. Allow students to test their airbags, evaluate error, and try it again.

**Grouping:** Students will be in groups of two to three and based upon heterogeneous mixtures. Students will assign roles within their group and make sure the roles are being followed. Suggested roles are as follows: facilitator, communicator, and reporter. The facilitator is responsible for collecting materials and keeping the group on task. The communicator is the only person within the group to ask the teacher questions. Group communication must happen first before the teacher is asked questions. The reporter is responsible for recording data to share with the group and submits any final paperwork required by the teacher.

**Exit Ticket:** Imagine that your airbag design has been accepted by an international automobile manufacturer. Unfortunately, after a few years, it is determined that the airbags are malfunctioning. There have been reports of the airbags exploding upon deployment. Malfunctions tend to occur in the summer, especially in very hot regions of the world where the temperatures in the car may reach 50° Celsius.

Using your understanding of kinetic molecular theory, and the variables involved in the ideal gas law, identify the problem with your airbag design and propose a possible solution. You may provide a particle diagram to illustrate your answer.