Lesson Plan: Mechanisms and Properties of Airbags

FOR THE TEACHER

Summary
In this lesson students will learn about the mechanisms and properties of airbags, and examine the choice of airbag inflator from several points of view.

Grade Level
High School

NGSS Standards
- HS-ETS1-1: Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
- HS-ETS1-2: Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
- HS-ETS1-3: Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability and aesthetics as well as possible social, cultural, and environmental impacts.
- HS-PS1-2: Construct and revise the explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.

Objectives
By the end of this lesson, students should be able to
- Explain the mechanism of an airbag, and how it protects an occupant in case of an accident.
- Justify the use of an airbag design system based on analysis of different stakeholder perspectives.

Chemistry Topics
This lesson supports students’ understanding of
- Chemical reactions
- Stoichiometry
- Gas laws

Time
Teacher Preparation: 20 minutes
Lesson:
- Engage: 5 minutes
- Explore: 40 minutes
- Explain: 80 minutes
- Elaborate: 40 minutes
- Evaluate: 40 minutes

Materials
- Students will need to register on the infographic site that you chose. Each of the suggested sites below allow free individual registration.
  - Piktochart
  - Canva
Safety

- No special safety considerations are required in this activity.

Teacher Notes

- **Engage:** Before showing the video, start by asking the class if anyone knows what gas is inside an airbag when it expands, and where this gas is stored in the car. Students may be surprised to learn that the gas is formed as a result of a chemical reaction. The video does a good job in showing the rapid expansion of the airbag. There is a second video which also can be shown which explains the chemistry of the airbag deployment and is an excellent companion to the first:
  - Video on Airbag Deployment (~4 minutes in length)
  - Optional second video (~2 minutes in length)

- **Explore:** The students will begin the research portion of the “Depicting Airbag Chemistry and Technology in an Infographic” assignment. Web sites listed on the student handout are a good starting point for airbag technology. Other web sites or articles can be used to supplement these resources.

- **Explain:** Students are asked to incorporate their research into an infographic that will be posted in the classroom. This is best done collaboratively in groups of 2 or 3. Both Piktochart and Canva offer free individual accounts and the ability to print or upload the infographics. Canva also offers the ability to save the infographic as a PDF. Students can either be directed to one site, or offered the option to pursue either. Kathy Schrock has an excellent 2 minute video, which gives tips for creating an infographics. As a minimum, before beginning this project, students should be aware of copyright restrictions on using others’ graphics and pictures.

- **Elaborate:** Students are shown the NBC news video about the Takata airbag recall. They are asked to take on different roles in the classroom as presented on “The Future of Airbag Technology” student handout, and think about future airbag development. From their perspectives, they brainstorm lists of criteria needed for the development of new airbag technology. Each group is asked to read a new set of web resources about airbag technology and develop a list of criteria needed for airbags of the future. The class then meets together to discuss the lists generated by the different groups. The Takata airbag technology hinged on the use of ammonium nitrate as a source of nitrogen gas. Students should be aware of this so they can discuss the pros and cons of alternate chemistries.

- **Evaluate:** Kathy Schrock has an excellent rubric for infographic evaluation, which is free to reproduce for classroom use: Copies of this rubric can be given to a student, and they can circle their evaluation of another students’ work using the rubric. Points can then be assigned to each descriptor and category, and totaled for each infographic. This would allow each infographic to be evaluated in the classroom.
FOR THE STUDENT
Lesson
Depicting Airbag Chemistry and Technology in an Infographic

Background
Airbags protect drivers and passengers in automobiles by providing a pillow of gas between them and a car frame, dashboard or windshield. You are going to research the chemistry and technology of an airbag, and explain this to others using an infographic. An infographic allows data to be sorted, arranged and presented visually. (Annie Colbert)

Objective
To produce an infographic which depicts airbag chemistry and technology.

Procedure
Part I: Research

1. Research the chemistry and technology of airbags. You should answer the questions below:
   - What are the parts of an airbag?
   - What gas is produced in an airbag deployment?
   - How is the gas produced?
   - What are the specific chemical reactions that produce the gas?
   - Can you describe the thermodynamics of the chemical reactions? For example, are they exothermic or endothermic?
   - How does an airbag protect an automobile occupant?

2. In addition, you should solve the following problem using stoichiometry and the ideal gas law. Incorporate the answer in your infographic:

   A standard air bag has a volume of 65 L. Assuming that the pressure = 1.00 atm and the temperature is 25 degrees C, what mass of sodium azide is needed for the reaction? In your calculation, you can assume that the first reaction (the decomposition of sodium azide) is the primary reaction for the production of nitrogen.

Here are some sites to start with:
- http://automotivesafetycouncil.org/resources_passive.asp?videoID=55#17
- http://www.carfax.com/guides/safety/airbag-technology
- http://illumin.usc.edu/88/the-engineering-behind-automotive-airbags/
- http://www.chemistry.wustl.edu/~edudev/LabTutorials/Airbags/airbags.html

Part II. Design the Infographic

1. Review the steps of making an infographic here.
2. Sketch a rough draft of an infographic by hand that displays the product of your research. Use this article, “10 Tips for Designing Infographics” to help you organize your research in a visually appealing form.

3. Create an account on piktochart.com or an equivalent site and design your infographic on the computer. Refer to the rubric as you design:

4. Print your infographic, and evaluate it using the rubric provided.

5. In class, use the provided rubric to evaluate another group’s infographic.

6. You must submit the following to your teacher for grading:
   a) The rough draft of your infographic, hand-drawn.
   b) The final infographic, printed out in color.
   c) A list of references.
   d) The infographic rubric, with a self-evaluation circled,
   e) The infographic rubric, with a peer-evaluation circled.

FOR THE STUDENT
Lesson
The Future of Airbag Technology

Background
Even though airbags protect drivers and passengers in automobiles involved in an accident, they can cause injury or death if the right materials or construction are not used. Your teacher will assign you to one of four stakeholder groups. In your group, you will decide on a list of criteria necessary for development of new airbag technology.

Objective
To analyze needed criteria for the future of airbag technology from the point of view of a stakeholder group.

Procedure
Part I: Research

1. After viewing the NBC news video about the expanded Takata airbag recall you will be assigned to one of four groups:
   a) consumers (purchasers of cars)
   b) airbag manufacturers
   c) automobile manufacturers
   d) government regulators

2. With your small group, discuss the video you just viewed. What criteria for airbag development were ignored when the Takata technology was developed?

3. With your small group, read the following two articles:
• Maker of Airbags Linked To 8M Recalled Vehicles Used Unusual Chemical Explosive for Inflation
• How Airbags are supposed to Work

4. Now, from the point of view of your group, brainstorm a list of criteria that are needed for new airbag technology. Consider social, cultural and environmental impacts of the new technology as you discuss. Record these criteria on a chart to share with the class.

5. Share your criteria with the rest of the class. What are the common criteria all groups agree on? Why? What are the criteria that differ between groups? Why?

6. Discuss with your class the similarities and differences you see in the lists.