Airbag Design Brief

Challenge: Design and build a model airbag system that will protect a raw egg from cracking in a simulated crash test.

Criteria/Specification: You are tasked with determining how much baking soda and vinegar to use in a reaction in order to inflate the airbag with enough CO_2 gas to protect your raw egg from cracking in a simulated crash test, but not so much that it pops your bag.

- Choose one particular sized plastic bag as your airbag model.
- Determine the maximum amount of CO_2 that can inflate the bag (in liters) without popping it. In other words, what is the volume of the bag?
- Determine the amount of baking soda and vinegar needed to react in order to produce that amount of CO_2 gas inside the bag with stoichiometry.
- Design, construct and test at least two prototypes. The box must be dropped from the height of your desk to simulate the crash.
- Provide mathematical evidence that the amounts of reactants used in your design are appropriate to meet the design requirements and constraints without the reactants being wasted.
- Record your testing data.
- Write a statement that justifies, using your data, the prototype you selected for final submission.

Resources: The following are resources available to you for constructing your prototypes.

- 4 sealable plastic bags (same size)
- 4 raw eggs
- 10 mL graduated cylinder
- 1 weighing boat
- 2 pipettes
- Balance
- Baking soda*
- Vinegar*
- 1 box (similar in size to plastic bag)
- Tape
- Rubber bands
- Sharpies



*The teacher will need to determine the maximum amount of reactants students should be given for each prototype based on the size of the bags provided for students. The boxes used for the cars should be similar to the size of the bags provided as well.

Evaluation:

Criteria	Advanced (4)	Proficient (3)	Developing (2)	Beginning (1)
Design	Students provided mathematical evidence to support design choices and the airbag is constructed well with the bag and egg well-secured inside the box.	Students provided some mathematical evidence to support design choices and the airbag is constructed well, but the egg and bag are not well-secured inside the box.	Students did not provide mathematical evidence to support design choices and/or the airbag does not work.	Students did not construct an airbag model.
Data	Airbag produces enough CO_2 to inflate and protect the egg in the simulated crash and does not exceed maximum volume of the bag. Data is recorded.	Airbag produces enough CO_2 to inflate and prevent some damage to the egg in the simulated crash. Data is recorded.	Production of CO_2 exceeds volume of the bag, causing it to pop, or the airbag does not inflate enough to prevent the egg from cracking during the simulated crash.	Airbag is not tested. Data is not recorded.
Redesign	Students create a second airbag model that works much better than the first one.	Students create an airbag that works slightly better than the first one.	Students are unsuccessful in improving their original airbag design.	Students do not attempt to improve original airbag design.
Justification	Student's justification is clearly reasoned and based on data.	Student's justification is based on data.	Student's justification is not clear or is not based on data.	Student does not write a justification.
Teacher Comments:				