

Lesson title: Protect the Pringle: Impulse and Force

Grade(s): Grade 10

Subject Area(s): Physics

Utah standard(s) addressed with this lesson:

Design a solution that has the function of minimizing the impact force on an object during a collision. *Define the problem, identify criteria and constraints, develop possible solutions using models, analyze data to make improvements from iteratively testing solutions, and optimize a solution.* Emphasize problems that require application of Newton's Second Law of Motion or conservation of momentum. (PS2.A, ETS1.A, ETS1.B, ETS1.C)

Learning objectives:

The learning objectives of this lesson are as follows:

- Students will be able to use the relationship between impulse and force to design a solution to a problem.
- Students will use an AI to augment the engineering design process
- Students will be able to present an effective design to other classmates based on scientific principles.

Safety concerns to be aware of for this lesson:

If teachers plan to use generative AI, they need to be aware of what product they are using. It is highly recommended that educators use a walled garden AI that will not learn from text students plug into the AI, as using a non-walled garden AI may violate privacy policies in districts. For this lab, I used **Schoolai**, a generative AI platform that is committed to student privacy and does not use student input to train from.

Key words and vocabulary:

Impulse: The change of momentum

Momentum: The strength of an object's motion

Lesson budget and materials list:

| Item | Cost | Website | Quantity | Total Item Cost |
|---|-------------------|----------------------------|----------------------|-----------------|
| 1.3m (4.26 ft) PVC tube (diameter 4 inches) | \$4.83 a foot | Home Depot | 1 4.26 ft section | \$21 |
| Printer Paper | \$6.67 for 500 | Amazon | 3-9 sheets per group | \$6.67 |
| Pringle Potato Chip | \$2 Per container | Walmart | 1-3 per group | \$2:00 |

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|---------------------|------------------------|--------------------------------|--|---------------|
| 28 oz Bottle | \$2 Per bottle | <u>Walmart</u> | 1 for the class | \$2.00 |
| Masking Tape | \$1.64 per roll | <u>Walmart</u> | 12-36 inches per group. Usually a roll covers a class | \$1.64 |

Lesson instructions (including pre-lesson activities):

Investigation: Students will be shown a video of a watermelon dropped onto concrete and a video dropped into water from the same height. Students will be tasked with explaining why one watermelon breaks while the other watermelon survives. Students will be given 3 minutes to think on their own, then 3 minutes to share with a neighbour, then the teacher will select a few students to share their ideas.

Instruction: Students will be shown a brief presentation on the concept of impulse being the change in momentum and that $impulse = F \cdot t$. This equation will be related to the investigation video on why the watermelon that fell in the water survived vs the watermelon that hit the concrete.

Engineering Design Project: Students will start the pringle chip challenge: building a container that will protect a single pringle chip from being crushed by a 28 oz bottle dropped from a height of 1.3 meters. For this challenge, students will be divided into groups of 2-3 and given 3 sheets of paper and 12 inches of masking tape per attempt. Students must build a structure around the pringle that will protect the pringle from being crushed by the falling bottle. Students are given 3 attempts, and are given a new set of paper, tape, and pringle for each attempt. Success is attained if the largest piece of the pringle that survives is at least 80% of the mass of the original. (Have students pick the largest piece from the post-test impact and weigh it on a scale. Most pringles are about 2 grams so a pringle piece that is at least 1.6 grams is a successful attempt)

To help with coming up with designs, students will describe their design to an **AI chatbot** that will provide suggestions to change and improve student designs. Students will then build their designs and test them, plugging their results back into the chatbot and updating their designs if they were unsuccessful.

Extension: Groups that succeed are asked to repeat the experiment with less resources (2 pieces of paper rather than 3)

Remediation: Students that are unsuccessful the first attempt can describe their design to the **AI chatbot** to get feedback and improvements about their design

Wrap up: Students will be asked to submit a sketch or picture of their final design with an explanation of what choices allowed the pringle to succeed. If students were not able to succeed in time a picture of their final design with what things to improve

Notes about the AI chatbot: In this lab it is important to program the chatbot you plan to use to specifically help with this lab. The following prompt was used for this lab:

You are a 10th grade physics chatbot. Students are trying to protect a potato chip from being crushed by a weight by building a protective structure made of 3 sheets of paper and 12 inches of masking tape. You are going to give suggestions on how to improve a student's design. Be sure to include topics such as impulse and momentum in your suggestion for improvements. Emphasize that increasing the collision time decreases the force on an object.

If and only if a student reports back that it is successful ask them to try again but with 1 less sheet of paper

Assessment:

Each student will submit a sketch or picture of their final design with an explanation of what choices allowed the pringle to succeed. If students were not able to succeed in time a picture of their final design with what things to improve. The exit ticket will be introduced 8 minutes before class ends

Other resources (powerpoints, worksheets, websites, video links, etc.):

[Watermelon Video](#)

[Link to Slides presentation](#)

[Link to SchoolAI Used](#)

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