Designing Solutions to Concussions

This unit will introduce students to the issue of concussions. Students will try to resolve this problem by ultimately designing a new helmet. Activities throughout will explain the physics of collisions and how materials can reduce concussion events.

# STANDARDS ALIGNMENT

**NGSS CONNECTIONS**

**MS-PS2-1:** Apply Newton’s Third Law to design a solution to a problem involving the motion of two colliding objects.

**TEKS CONNECTIONS**

**8.6C:** investigate and describe applications of Newton’s three laws of motion such as in vehicle restraints, sports activities, amusement park rides, Earth’s tectonic activities, and rocket launches

# LEARNING OBJECTIVES

**Students will know:**

* Newton’s three laws of motion
* The relationship between force, time, mass, and change in velocity.

**Students will understand:**

* How the application of force to the head can cause trauma
* How helmet materials reduce the chances of concussions.

**Students will be able to:**

* Complete the engineering design process to protect an egg from a fall
* Analyze data (including force, velocity, acceleration, and time) to determine the most protective material for a collision.
* Analyze data by creating tables and graphs.

# UNIT PLAN

## Problem

Students will watch the introductory video [“What happens when you have a concussion?”](https://www.youtube.com/watch?v=xvjK-4NXRsM) by TED-Ed. Students will then identify the problem at hand and will brainstorm solutions to this problem.

* [What’s going on and how can we help?](https://drive.google.com/file/d/1_nZzBHMovsrI-jQ1lGYIV_5sKJT-f8aN/view?usp=sharing)

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| In classroom | Synchronous online | Asynchronous online |
| Video can be played via projector.  As a class, discuss what issue or problem this video introduced. Students can work in groups to brainstorm possible solutions to the problem. | Video can be shown as a screen share in a presentation or on their own. They can also be provided to students before the session.    As a class, discuss what issue or problem this video introduced. This can be done using Pear Deck or something as simple as the chat window in the video conferencing platform.  Breakout rooms can be used for students to work in groups to brainstorm possible solutions to the problem. | Video can be provided on the school LMS in the form of an assignment.    Students can discuss possible solutions they have via a forum in the LMS or group Google documents. |

Common solutions might include:

* Better helmets
* Changing sport rules
* Adding sensors to helmets to detect concussions

Students will be guided through the following activities to help them understand the physics of collisions before attempting to design a helmet as a solution to this problem.

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## Activities

### *Bouncing Balls: Understanding Momentum*

* Students will drop three different balls on a surface and measure the bounce height. This will introduce the relationship between mass and momentum to the students.
  + [Bouncing Balls: Understanding Momentum](https://drive.google.com/file/d/1Kqf7TM12pTM3m0zzd_vqQjMCud14JU5p/view?usp=sharing)

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| In classroom | Synchronous online | Asynchronous online |
| Students can work on the experiment during class and can work on the calculations and conclusions in partners or small groups.  A review of the content after the experiment is completed is advised. | The instructor can demo the activity during class time to help students collect the bounce height data.  Breakout rooms can be used to have students work on the calculations and conclusions.  Then a review of the content should be shared out as a class. | A video of the experiment from an instructor can be provided. Or this [video](https://www.teachengineering.org/activities/view/cub_energy_lesson03_activity3) can be provided.  Alternatively, students can complete the activity at home on their own.  A review of the main concepts is advised in either a written or video format. |

### Egg Drop Challenge

* Students will design a protective barrier for an egg, so that the egg can survive a drop from 4, 6, and 8 ft. This will introduce students to the protective materials.
  + [Egg Drop Challenge](https://drive.google.com/file/d/1VPdsIj9PxehTQJHAmTwY1OvNzSPROQN4/view?usp=sharing)

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| In classroom | Synchronous online | Asynchronous online |
| Students can work on the experiment during class and can work on the calculations and conclusions in partners or small groups.  A review of the content after the experiment is completed is advised. | The instructor can demo the activity during class time to help students collect the data. Students could vote for materials to use or how to use them.  Breakout rooms can be used to have students work on the calculations and conclusions.  Then a review of the content should be shared out as a class. | A video of the experiment from an instructor can be provided.  Alternatively, students can complete the activity at home on their own.  A review of the main concepts is advised in either a written or video format. |

### Egg Drop Simulation

* Students use a simulation to collect data regarding the egg’s change in velocity, the time of the collision, and the force experienced. The main takeaway from this is that the force can be lowered by increasing the time of the collision. This force experienced by the egg is the same force felt by the floor surface.
  + [Egg Drop Simulation](https://drive.google.com/file/d/1NYBctyi7X_pbEFIum5QjaNCILNuITGqi/view?usp=sharing)

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| In classroom | Synchronous online | Asynchronous online |
| Students can work on the simulation in partners to complete the worksheet.    After completion, the instructor should facilitate a class discussion about how this relates to Newton’s Third Law. | Instructor can demo the simulation to teach how the data is collected.  Then students should work in small groups or pairs if possible to complete the worksheet before returning to the main group for a review of this simulations relation to Newton’s Third Law. | Students can work on the simulation and worksheet on their own.    A video or text review of how the simulation relates to Newton’s Third Law can be provided. |

### Football in the Lab

* Students discuss data collected by reconstructed NFL collisions that resulted in concussions. Students will graph data to learn how acceleration and impact force are related. Students will also compare collisions that resulted in concussions and collisions that did not in the form of a bar graph.
  + [Football in the Lab](https://drive.google.com/file/d/1PzdeX4R2qbhcJwDR1CUutbcUVyS4Fhk8/view?usp=sharing)

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| In classroom | Synchronous online | Asynchronous online |
| Students can work in small groups to work on the graphs together.  A review of how to draw a line of best fit is recommended. | Instructor can introduce the scientific paper and how they collected their data.  In breakout rooms, students can work in groups on a single Doc or Jamboard to make the necessary graphs. | Students can work on the worksheet on their own.  A video or text review of how the information helps us understand concussions is recommended. |

1. *Designing a Safer Helmet*

* Students pick a material to use in a new helmet design. Students then analyze the provided data to compare their material to no protection and see how the values of force and time of collision differ.
  + [Designing a Safer Helmet](https://drive.google.com/file/d/1xERTh1HaHi8JDU1YmNbmUX1UKFpK1PNX/view?usp=sharing)

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| In classroom | Synchronous online | Asynchronous online |
| Students can work in small groups to design their helmet and pick their material. Then in small groups they can work on their calculations.  As a class, the instructor should review the materials and as a class they should rate them from worst protection to best protection | Instructor can introduce the activity and the task for the students.  In breakout rooms, students can work in groups on a single Doc or Jamboard to complete the calculations and conclusions.  As a class, the instructor should review the materials and as a class they should rate them from worst protection to best protection | Students can work on the worksheet on their own.  A video or text review of how the information helps us understand concussions is recommended. |

## Conclusions

* Students design a poster advertisement for their newly designed helmet, complete with slogans, pictures, and data.
  + [Evaluating a Design](https://drive.google.com/file/d/1YnvUJbPLWIZVor6ZaNBFwLE1tqVL43KS/view?usp=sharing)

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| In classroom | Synchronous online | Asynchronous online |
| Students can work on this individually, then in pairs or small groups.    Groups can present their advertisement to the other groups and students should provide feedback on the presentation. | Students in small groups can brainstorm and think of preliminary ideas. This can be done before the synchronous session.    Groups can present their poster (Jamboard or Google Slide) to the other groups and students should provide feedback on the presented product. | Students in small groups can brainstorm and think of preliminary ideas. This can be done via a shared Google Doc.    Groups can present their advertisement via video or simple poster design on a class forum for feedback. |