Buckle Up

Physical Science

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Grade Level	9th Grade	**Time Frame**	250 minutes
Subject	Science	**Duration**	4–5 periods
Course	Physical Science		

Essential Question

What happens when two objects interact with each other? What important constraints can help reduce changes occurring on an object in motion?

Summary

This lesson is best taught after students have already explored how speed, velocity, and mass determine momentum in terms of Newton's first and second laws. Here, students will take those principles and determine Newton's third law, including what occurs when two objects act upon one another. Students will learn that for every action, there is a reaction. Then they will find ways to reduce momentum (the action) when a collision occurs (the reaction). This is a multimodality lesson, which means it includes face-to-face, online, and hybrid versions of the lesson. The attachments also include a downloadable Common Cartridge file, which can be imported into a Learning Management System (LMS) such as Canvas or eKadence. The cartridge includes interactive student activities and teacher's notes.

Snapshot

Engage

Students develop an initial model, sharing similarities and differences among a group of peers. Then, they determine the law that applies to the models.

Explore

Students review Newton's third law, which is shown through real-world activities. Each student chooses an image that depicts Newton's third law and adds a hashtag to accompany the image. Then, each student chooses a peer's image and explains how it represents Newton's third law.

Explain

Students annotate an article that connects Newton's three laws to safety measures used in collisions.

Extend

Students construct a model that helps reduce the momentum on an object(s) in a collision.

Evaluate

Students submit a Safety First Engineering Presentation and share their findings.

Standards

ACT College and Career Readiness Standards - Science (6-12)

IOD403: Translate information into a table, graph, or diagram
SIN401: Understand a simple experimental design
EMI503: Identify the strengths and weaknesses of models

Oklahoma Academic Standards (Physical Science)

PS.PS2.3 : Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.*
PS.PS2.3.1: If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by change in the momentum of objects outside the system.
PS.PS2.3.2: Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account;and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them.

Attachments

- Common Cartridge—Buckle Up.zip
- Discussion Group Slides (Online)—Buckle Up.pptx
- Draw an Initial Model - Buckle Up.docx
- Draw an Initial Model - Buckle Up.pdf
- Engage Activity (Online)—Buckle Up.pptx
- Lesson Slides—Buckle Up.pptx
- Physics and Car Safety - Buckle Up.docx
- Physics and Car Safety - Buckle Up.pdf
- Pick a Pic (Online)—Buckle Up .pptx
- Safety First Engineering Instructions - Buckle Up.docx
- Safety First Engineering Instructions - Buckle Up.pdf
- Safety First Engineering Rubric - Buckle Up.docx
- Safety First Engineering Rubric - Buckle Up.pdf
- Safety First Engineering Trials - Buckle Up.docx
- Safety First Engineering Trials - Buckle Up.pdf

Materials

- Lesson Slides (attached)
- Draw an Initial Model handout (attached; one per student)
- Engage Activity handout (online) (attached; one per student)
- Discussion Group Slides (online) (attached)
- Pick a Pic (online) (attached)
- Physics and Car Safety handout (attached; one per student)
- Safety First Engineering Instructions (attached; one per student)
- Safety First Engineering Presentation Rubric (attached; one per student)
- Safety First Engineering Trials (attached; one per student)
- Maker Cart 2.0 from TeacherGeek (if purchased or available)
- 1.2 m PAScar Dynamics System from PASCO (if purchased or available)
- PASCO Smart Carts (if purchased or available)

55 minutes

Engage

Use the attached **Lesson Slides** to follow along with the lesson. Begin with **slide 3.** Briefly, read aloud the essential questions, "What happens when two objects interact with each other? What important constraints can help reduce changes occurring on an object in motion?" Then, move to **slide 4** and read the objectives.

Invite students to watch two video clips. Before beginning the first clip, ask students to identify common concepts in both videos as they watch. These concepts should be familiar, as students should have learned about them in previous units on Newton's laws. Go to **slide 5** and play the video compilation *3+ Minutes of People Walking into Glass Compilation*, starting at the 2:50 mark. Play the video from the 2:50 mark to the 3:17 mark.

Embedded video
https://youtube.com/watch?v=ebdZlh0U4Os

Then, move to **slide 6** to show the video *Second Chance*. Before playing the video, inform students that it includes a realistic depiction of a car crash and provide the opportunity for students to avoid watching it if preferred.

Embedded video
https://youtube.com/watch?v=L62ueMB0E5E

Go to **slide 7.** After viewing both videos, distribute a copy of the attached **Draw an Initial Model** handout to each student. Students should use the handout to draw an initial model of the forces they witnessed through the videos. Next, sort students into groups of 3–4.

Teacher's Note: Discussion Groups

Be sure that you decide students' groupings for this activity instead of having students group themselves. Walk around and monitor students to address any possible questions that may arise, but don't give answers to how students should depict the forces they saw or how they should summarize.

Have students share their initial models and summaries with their group members. Have them record similarities and differences among their drawings. As a group, they should create an explanation of what is occurring and which of Newton's laws applies. Have each group share out their explanations.

20 minutes

Explore

Work with students to determine an agreed-upon explanation for what they saw happen in the videos. Then, move to **slide 8.** Explain that for every action there is a reaction, which is referred to as Newton's third law. Have students contemplate some other scenarios in which they've seen the same type of collision.

Teacher's Note: Padlet Preparation

To use the Padlet application in the following activity, log into the site and prepare a Padlet board for your class.

If using Padlet is not a good option for your class, you may choose to use the attached **Pick a Pic (Online)** slides, adding slides if necessary.

Go to **slide 9.** Invite students, using the Pick a Pic strategy, to find an image that shows a reaction similar to the ones we saw in the videos. Have students add their pictures to Padlet and add a hashtag to the picture that describes what it is about (for example, "#carcrash").

Next, introduce students to the Gallery Walk strategy. Invite students to take part in a virtual Gallery Walk of their classmates' pictures. Students should choose a picture that hasn't been selected by another student yet, add a hashtag caption, and explain how it reflects Newton's third law. Allow about 15 minutes for students to do so.

Alternative Virtual Activity

If working in an asynchronous virtual platform, have students include a date and time for their initial image posts as well as for their peer response posts. Be sure to have students add their names or initials next to their posts and peer responses. For an Honors class, have students include what safety measures are being used or could be used to help minimize the effects of the impact.

45 minutes

Explain

Go to **slide 10**. Introduce students to the C.R.U.S.H. and Smush strategy. Distribute a copy of the attached **Physics and Car Safety** article to each student, inviting them to C.R.U.S.H and Smush the article according to the following directions:

- **Circle** any new vocabulary. Look up each definition and, in the margin of the reading, record a sentence that uses each circled word correctly.
- **Read** the article using your knowledge of the new vocabulary words.
- **Underline** the vocabulary you already know.
- **Star** the main ideas throughout the reading.
- **Highlight** evidence that supports the main idea. (Note that students should not highlight every line after the main idea. They should select key points that support the main ideas.)
- Summarize and condense (**smush**) the article into your own words. (Students' summaries should take each idea and pull all the evidence together to explain the article in 3–5 sentences.)

Give students about 40 minutes to do so. Once completed, have students share their summaries and then hand in their annotations for evaluation.

120 minutes

Extend

Teacher's Note: Activity Prep

If you or your school has access to a Maker Cart 2.0 from TeacherGeek, 1.2 m PAScar Dynamics System from PASCO, and/or PASCO Smart Carts (or similar), students can use them to create and test their collision models.

Optional Career-Focused Activity

The following activity can be used to add a career exploration element to this lesson.

Go to **slide 11.** Tell students: "Today, we are going to learn about two professions that need to understand the physics of car crashes, but from two vastly different angles." Invite students to watch a video to introduce these professions. Ask students to consider, as they watch, what kind of research they would need to do on Newton's laws in order to be successful at these jobs.

For students to answer this question as they watch, you can use either of the following methods.

Open-Ended Questions: After watching each video, ask students one of the questions below as instructed.

Mentimeter: To use Mentimeter, you will need to visit the site and create an account (or log in) and create two open-ended questions in advance. Prepare the questions below.

1. What kind of evidence related to Newton's laws would Mr. Marshall need to take into consideration in a case concerning a car crash?
2. Describe, in three sentences or less, how Ms. Schneberger uses her degree in chemical engineering to make cars safer and to decrease the momentum of an object in a car collision.

First, play the video *Career-Focused—Attorney & Chemical Engineer with Jason Marshall & Tarah Scheberger*.

Embedded video
https://youtube.com/watch?v=3OBNpJQxQrs

Pause the video at the 2:27 mark and have students answer open-ended question #1 (using a class discussion format or using Mentimeter). Resume the YouTube video. Once the video is over, have students answer open-ended question #2 in the same way.

Once students have watched the video and answered the questions, go to **slide 12.** Ask students to think of a job they are interested in pursuing or that they find fascinating. Highlight how that occupation institutes safety procedures to reduce momentum on an object and explain why those safety precautions are essential to that job. If a student chooses an occupation without clear safety procedures (an artist, for example), you can give an example that focuses on a peripheral part of the job (using the example of an artist choosing safe packaging to transport a work of art).

Then, move on to the activity below.

Go to **slide 13.** Invite students to create a collision model of their own.

Optional Maker Cart

If you have access to a TeacherGeek Maker Cart, invite students to use the trinkets from the cart to construct their models.

Distribute to each student a copy of the attached **Safety First Engineering Instructions** handout and **Safety First Engineering Presentation Rubric.**

Invite each student to create three trials for a collision model of their choice. The goal is to improve safety precautions with each trial. Place students into groups of 3–4.

Optional Smart Carts

If you have access to a PASCO 1.2 m PAScar Dynamics System and Smart Carts (or similar), you can use these to keep a constant distance for each collision trial. Students can use Smart Carts to measure their initial and final readings of force, position, and/or velocity.

Once ready to begin, guide students through the following steps of the experiment. You may choose to have students record videos of each trial, take before and after photos, or sketch and explain each trial on the attached **Safety First Engineering Trials** handout.

- In the first trial, ask students to determine the effects of the collision when no safety precautions are taken. For example, a learner may put a Barbie doll (the object) in a toy car without a seatbelt, and then create a collision between the car and a wall (or another car, etc.). Another learner might drop an egg with no safety restraints or cushions to the ground.
- In the second trial, ask students to add a safety precaution and determine what impact it has on the momentum of the object.
- In the third trial, ask students to improve the safety precautions and determine how it decreased the momentum of the impact on the object.

10 minutes

Evaluate

Go to **slide 14.** Invite students to create a presentation of their own. This may take the form of a Prezi, PowerPoint slides, a trifold presentation, or a video or audio recording using the attached **Safety First Engineering Instructions** packet.

Teacher's Note: Types of Presentations

If students decide to create a PowerPoint or other slide-based presentation, they should have separate slides for the following:

1. A slide that explains their introduction
2. A different slide for each trial
3. A conclusion slide that follows the Safety First Engineering Instructions and rubric specifications

Be sure to have students refer to the Safety First Engineering instructions and rubric specifications for each slide. There should be at least 5 slides in total: an introduction slide, a slide for each trial (three total), and a conclusion slide.

If following an asynchronous teaching format, you can instead have students pre-record their presentations. This can also be used to alleviate students' anxiety about presenting. For this type of presentation, consider giving students a time limit between 5 and 10 minutes for their presentations.

Each student's presentation should include the following:

- Introduction
- Objectives
- List of materials used throughout the experiment
- Procedure used to design and construct the model (including pictures)
- Explanation of all three trials, especially relating to what the student learned about reducing the momentum of the object in a collision
- A completed version of the data table below (also provided on page 3 of the Safety First Engineering Instructions packet)
- A summary of the data table; this summary should incorporate learned terminology and should explain the role of speed, momentum, acceleration, and force.

Give students a specific date by which they should submit their presentations. (If using Canvas, have students upload and submit to Canvas directly.) You may also have students review the Safety First Engineering Presentation Rubric before they begin.

Allow students time to work on their presentations.

Once projects are finished and submitted, go over proper presentation etiquette with students before they present. This includes discussing attire, eye contact, posture, and projection. Finally, have students present their projects to the class.

Resources

- K20 Center. (n.d.). C.R.U.S.H. & Smush. Strategies. https://learn.k20center.ou.edu/strategy/821
- K20 Center. (n.d.). DocHub. External apps tutorials. https://k20center.ou.edu/externalapps/dochub/
- K20 Center. (n.d.). Four corners. Strategies. https://learn.k20center.ou.edu/strategy/138
- K20 Center. (n.d.). Gallery walk / carousel. Strategies. https://learn.k20center.ou.edu/strategy/118
- K20 Center. (n.d.). Mentimeter. Tech Tools. https://learn.k20center.ou.edu/tech-tool/645
- K20 Center. (n.d.). Padlet. External apps tutorials. https://k20center.ou.edu/externalapps/padlet/
- K20 Center. (n.d.). Padlet. Tech Tools. https://learn.k20center.ou.edu/tech-tool/1077
- K20 Center. (n.d.). Pick a pic. Strategies. https://learn.k20center.ou.edu/strategy/91
- K20 Center (2020, December 14). *K20 ICAP - Attorney & chemical engineer - Buckle up* [Video]. YouTube. https://youtu.be/3OBNpJQxQrs
- List Posts. (2019, February 12). *3+ minutes of people walking into glass compilation* [Video]. YouTube. https://www.youtube.com/watch?v=ebdZIh0U4Os
- USDOTNHTSA. (2015, May 8). *Second chance* [Video]. YouTube. https://www.youtube.com/watch?v=L62ueMB0E5E