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 1st and 2nd laws. Here, students will take those principles and determine Newton's 3rd 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

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 - Spanish.pptx
- Discussion Group Slides (Online)—Buckle Up.pptx
- Draw an Initial Model—Buckle Up - Spanish.docx
- Draw an Initial Model—Buckle Up - Spanish.pdf
- Draw an Initial Model—Buckle Up.docx
- Draw an Initial Model—Buckle Up.pdf
- Engage Activity (Online)—Buckle Up - Spanish.pptx
- Engage Activity (Online)—Buckle Up.pptx
- Lesson Slides—Buckle Up.pptx
- Physics and Car Safety—Buckle Up - Spanish.docx
- Physics and Car Safety—Buckle Up - Spanish.pdf
- 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 - Spanish.docx
- Safety First Engineering Instructions—Buckle Up - Spanish.pdf
- Safety First Engineering Instructions—Buckle Up.docx
- Safety First Engineering Instructions—Buckle Up.pdf
- Safety First Engineering Presentation Rubric—Buckle Up - Spanish.docx
- Safety First Engineering Presentation Rubric—Buckle Up - Spanish.pdf
- Safety First Engineering Presentation Rubric—Buckle Up.docx
- Safety First Engineering Presentation Rubric—Buckle Up.pdf
- Safety First Engineering Trials—Buckle Up - Spanish.docx
- Safety First Engineering Trials—Buckle Up - Spanish.pdf
- Safety First Engineering Trials—Buckle Up.docx
- Safety First Engineering Trials—Buckle Up.pdf

Materials

- Set-up that allows videos and PowerPoints to be played for everyone to view (for the Engage and Explain phases)
- Common Cartridge (attached)
- Lesson Slides (attached)
- Draw an Initial Model (attached; one per student)
- Engage Activity (attached; one per student)
- Discussion Group Slides (Online) (attached)
- Pick a Pic (Online) (attached)
- Padlet

- The Physics of Safety Article Explain (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)

55 minutes

Engage

If completing this activity as a class virtually, 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.

Teacher's Note: Synchronous or Asynchronous Learning

If completing as a class, you can share the videos with the class and ask them to look for a common concept occurring in both videos that they learned in the previous units.

If students are completing on their own, have students watch on their own time and complete the initial post by a particular date, with peer responses due by a later specified date.

For an Honors class, you can have students draw an initial model (diagram) of the forces exhibited through A Web Whiteboard. (They should not copy and paste images from the internet.) For instructions on how to use A Web Whiteboard, view the K20 Center's Intro to A Web Whiteboard video.

Students can also draw their initial model on the paper version of the attached **Draw an Initial Model** handout, take a picture of the finished model, and add it to their group's slide.

Invite students to watch two video clips. Ask students as they watch 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.
- Move to **slide 6** to show the video "Second Chance."

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

Teacher's Note: Discussion Groups

For this next activity, be sure that you decide students' groupings for this activity instead of having students group themselves. You can do this by adding students' names and groups to the second slide of the attached **Discussion Group Slides.**

Go to **slide 7.** After viewing both videos, distribute the attached **Engage Activity (Online)** slides for students to determine the forces they witnessed through the video. Students should screenshot their images & summaries to add into the attached **Discussion Group Slides (Online)** as detailed below.

For the next activity, introduce students to the Four Corners strategy. Share with students the **Discussion Group Slides (Online)**. Sort students into groups for this activity by adding their names to the appropriate row on slide 2 of the Discussion Group Slides. Be sure that the Discussion Group Slides are shared with the whole class so all students can collaborate in the same copy of the slides. Each student should add their initial model and summary to **both** of their group's assigned Four Corners slides in the Discussion Group Slides. Students should discuss their models' similarities (using the first of their assigned slides) and differences (using the second of their assigned slides) and come up with a group explanation of what is occurring. Last, in their groups, students should determine based on their group's explanation which of Newton's laws they are studying.

Teacher's Note: Engage Activity (Online) Slides

Working in the Engage Activity (Online) slides, students should move the arrows provided on slide 3 of the Engage Activity Slides to show the direction in which forces are moving before and after the modeled crash, labeling these arrows "before" or "after." Students should then give a two-sentence summary of what they believe is occurring with forces and movement based on the model they created.

Have each group member individually submit their group's explanation and law into your learning management system.

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 (without saying aloud) some other scenarios in which they've seen the same type of collision.

Activity Preparation: Padlet

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 learners to, using the Pick a Pic strategy to find an image that shows a reaction similar to the ones we saw in the videos. Have learners add their pictures to Padlet or to the **Pick A Pic (Online)** slides. (For more information on adding pictures to Padlet, see the K20 Center's Padlet tutorial.) Then, invite learners to add a hashtag to the picture that describes what it is about (for example, "#carcrash"). Give them about 15 minutes to do so.

Next, introduce students to the Gallery Walk strategy. Invite students to take part in a virtual Gallery Walk of their classmates' pictures in Padlet. 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. Then, review the Gallery Walk activity with learners.

Teacher's Note: Asynchronous Learning

If students are completing on their own, have students include a date & time for their initial image posts and as well as for their peer response posts. Be sure to have learners add their names or initials next to their posts and peer responses.

For an Honors class, have learners include what safety measures are being used or could be used to help minimize the effects of the impact.

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 Discussion Group Slides, adding slides if necessary.)

For more information, see the K20 Center's Padlet tutorial.

45 minutes

Explain

Introduce students to the C.R.U.S.H. and Smush strategy. Distribute a copy of the attached **The Physics of Car Safety** to each student, inviting them to C.R.U.S.H and Smush the article according to the strategy's 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.)

Once completed, have students share out their summaries and then hand in their annotations.

Tech Intagration: DocHub

One annotation tool you can use is a program called DocHub. For more information, see the K20 Center's DocHub tutorial.

Teacher's Note: Synchronous Teaching

If completing as a class, 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

Optional: ICAP Activity

This version of the activity can be used to add a career exploration element to this lesson.

The extend and evaluate are intended to go together. Go to **slide 11.** Tell learners: "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 learners 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.

Edpuzzle: Have learners watch "ICAP - Buckle Up" on Edpuzzle. Here, the questions are already embedded in the video. For further instructions Edpuzzle—or more information on how you can use it for other lessons—see the K20's Center's Edpuzzle Tech Tool resource.

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. For further instructions on how to create your own Mentimeter, see the K20 Center's Mentimeter Tech Tool resource. Prepare the following questions:

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 "ICAP - Buckle Up" through YouTube.

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

Pause the video at the 2:27 mark and have students answer open-ended question #1 in Mentimeter. Resume the YouTube video. Once the video is over, have students answer open-ended question #2 in Mentimeter.

Once students have watched the video and answered the questions, go to **slide 12.** Ask learners 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 (such as, for an artist, choosing the packaging needed to transport a work of art).

Go to **slide 13**. Invite students to create a collision model of their own. Distribute to each student a copy of the Go to **slide 13**. Invite learners to create a collision model of their own. Distribute to each learner a copy of the **Safety First Engineering Instructions** and **Safety First Engineering Presentation Rubric**.

Invite each learner to create three trials for a collision model of their choice. The goal for each trial is to improve safety precautions with each trial. Invite learners to work online to create their own models. Be sure to emphasize that learners should use only inanimate (non-living) objects in their models.

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

- In the first trial, ask students to determine the effects of the collision when no safety precautions are taken.
- 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.

Then, move on to the Evaluate activity below.

Non-ICAP Version

The Extend and the Evaluate are intended to go together. Go to **slide 13**. Invite learners to create a collision model of their own. Distribute to each learner a copy of the **Safety First Engineering Instructions** and **Safety First Engineering Presentation Rubric**.

Invite each learner to create three trials for a collision model of their choice. The goal for each trial is to improve safety precautions with each trial. Invite learners to work online to create their own models. Be sure to emphasize that learners should use only inanimate (non-living) objects in their models.

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

- In the first trial, ask students to determine the effects of the collision when no safety precautions are taken.
- 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.

10 minutes

Evaluate

Go to **slide 14.** Invite learners to create a presentation of their own. This may take the form of a Prezi, PowerPoint, a trifold presentation, or a video or audio recording using the attached **Safety First Engineering Instructions** packet. The presentations should be uploaded and submitted via your learning management system.

Teacher's Note: Types of Presentations

If learners 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 5-10 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. 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). ICAP - Buckle Up. YouTube. https://youtu.be/3OBNpJQxQrs
- List Posts. (2019, February 12). 3+ Minutes of People Walking into Glass Compilation. YouTube. https://www.youtube.com/watch?v=ebdZIh0U4Os
- USDOTNHTSA. (2015, May 8). Second Chance. YouTube. https://www.youtube.com/watch?v=L62ueMB0E5E