

Action, Reaction

Forces and Motion

Alonna Smith
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Grade Level	8th Grade	**Time Frame**	4-5 class period(s)
Subject	Science	**Duration**	250 minutes

Essential Question

How does our knowledge of energy transfer influence our daily lives?

Summary

This lesson guides students to apply Newton's third law of motion and has them find solutions to problems associated with collisions. During the lesson, students observe various forms of collisions, examine and explain evidence that supports Newton's third law of motion, and identify real-world problems involving the transfer of energy and collisions. Students apply their understanding of these concepts to design, test, modify, and compare helmet designs. At the end of the lesson, students summarize their learning by creating a PSA (Public Service Announcement) about how to stay safe in the event of a collision.

Snapshot

Engage

Students watch a video about collisions in football and record things they notice and wonder about the video.

Explore

Students participate in activities at three different stations that allow them to observe Newton's third law of motion.

Explain

Students complete a T-Chart individually and as a class to demonstrate and discuss what they discovered at the activity stations.

Extend

Students research, design, build, and test a helmet for an egg, apple, or melon.

Evaluate

Students create a PSA about how to stay safe during a collision.

Standards

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

IOD304: Determine how the values of variables change as the value of another variable changes in a simple data presentation
SIN301: Understand the methods used in a simple experiment
EMI404: Identify similarities and differences between models
EMI503: Identify the strengths and weaknesses of models

Next Generation Science Standards (Grades 6, 7, 8)

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

Oklahoma Academic Standards (8th Grade)

8.PS2.1 : Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects in a system.*
8.PS2.1.1: For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction (Newton's third law).

Attachments

- Bell Ringer—Action, Reaction - Spanish.docx
- Bell Ringer—Action, Reaction - Spanish.pdf
- Bell Ringer—Action, Reaction.docx
- Bell Ringer—Action, Reaction.pdf
- Design a Helmet—Action, Reaction - Spanish.docx
- Design a Helmet—Action, Reaction - Spanish.pdf
- Design a Helmet—Action, Reaction.docx
- Design a Helmet—Action, Reaction.pdf
- Interacting Forces T-Chart—Action, Reaction - Spanish.docx
- Interacting Forces T-Chart—Action, Reaction - Spanish.pdf
- Interacting Forces T-Chart—Action, Reaction.docx
- Interacting Forces T-Chart—Action, Reaction.pdf
- Lesson Slides—Action, Reaction.pptx
- PSA—Action, Reaction - Spanish.docx
- PSA—Action, Reaction - Spanish.pdf
- PSA—Action, Reaction.docx
- PSA—Action, Reaction.pdf
- Stations Journal—Action, Reaction - Spanish.docx
- Stations Journal—Action, Reaction - Spanish.pdf
- Stations Journal—Action, Reaction.docx
- Stations Journal—Action, Reaction.pdf

Materials

- Lesson Slides (attached)
- Bell Ringer handout (attached, one per student)
- Stations Journal handout (attached, one per student)
- Interacting Forces T-Chart handout (attached, one per student)
- Design a Helmet handout (attached, one per group of 2–4 students)
- PSA handout (attached, one per student)
- Newton's cradle (several, if available)
- Dice within dice sets (several sets, if available)

- Balloons
- Fishing line
- Straws
- Tape
- Scratch paper
- Eggs, apples, or melons
- Helmet building materials (May include paper, cardboard, bubble wrap, egg cartons, or any other available materials)
- Sticky notes

10 minutes

Engage

Use the attached **Lesson Slides** to guide the lesson. Introduce the lesson title, essential question, and lesson objectives on **slides 2–4**.

Display **slide 5** and distribute one copy of the attached **Bell Ringer** handout to each student. Use the Bell Ringer instructional strategy to have students engage with their prior knowledge about a collision they have experienced or witnessed. Encourage students to consider any kind of collision like a car collision or a person colliding with another person or an object. Invite volunteers to share out their responses and encourage a class discussion. Focus on equal and opposite reactions during the discussion, but avoid academic terms like action, reaction, force, and energy unless students bring up the terms first.

Show **slide 6** and direct students' attention to the I Notice, I Wonder chart on their Bell Ringer handouts. Tell students to jot down what they observe and any questions they may have as they watch the video. Play the video *The New Football Helmet Test that Could Save Kids from Concussions* on the slide.

As students work, create an I Notice, I Wonder class chart on the board or on chart paper. Invite students to share out things they noticed and wondered and record their responses on the class chart.

Embedded video

https://www.youtube.com/watch?v=Aa53zQlnpe4

30 minutes

Explore

Teacher's Note: Station Set-Up

Prior to this portion of the lesson, set up three stations around the classroom. Each station allows students to interact with the principles of Newton's third law of motion. Consider setting up two of each station to limit the number of students at one station. Directions for each station are listed below.

Balloon Rocket Station: Cut 10–15 feet of fishing wire and place the wire, balloons, straws, and tape at one station. Consider showing students the *Balloon Rocket Science Experiment* video prior to conducting the experiment to help them set up the balloon.

Newton's Cradle Station: Place one Newton's cradle at one station. If you are able to, set up multiple Newton's cradles so more students can interact with the device at once.

Double Dice Station: Place at least one double dice at one station. If you are able to, set up multiple double dice so more students can interact with the dice at once. Ensure that there is space for students to roll the dice.

Display **slide 7** and pass out one copy of the attached **Stations Journal** handout to each student. Notify students that they should rotate to each station and conduct the experiment at each station according to the directions on their handouts. Tell students that at each station they should observe patterns and collected data on interacting forces. Start the 7-minute timer on the slide and instruct students to switch stations when the timer goes off. Restart the timer after students rotate to a new station.

As students work, walk around the room and ensure that students are conducting each experiment according to the directions. At the Balloon Rocket Station, students may need help correctly setting up the experiment. Assist students with answering any questions they may have about the balloon rocket, double dice, and Newton's cradle.

After students have rotated to each station, lead a whole-class discussion about the patterns students noticed between stations. Review the questions on the Stations Handout and invite students to share their responses.

25 minutes

Explain

Display **slide 8** and distribute one copy of the attached **Interacting Forces T-Chart** handout to each student. Have students summarize what they learned about interacting forces at each station using the T-Chart. Have them list facts they learned on the left side of the chart then have them record or diagram evidence that supports each fact on the right side of the chart.

As students work, create a class T-Chart on the board or on chart paper. Invite volunteers to share out information they learned during the station activities and record their responses on the chart. Have students guide you to diagram evidence on the right side of the chart or have them share information that supports the claims present on the left side of the chart.

Sample Student Responses

Students may share facts for the left side of the chart like how air came out in one direction and the balloon moved in the opposite direction when they released it. They may also share that when one marble of the Newton's cradle was pulled up and released, the marble on the opposite side bounced up.

Transition to **slide 9** and introduce Newton and Newton's third law of motion to the class. You may consider mentioning Newton's first and second laws of motion as well. Help students connect Newton's third law of motion to their experiences at the stations in the Explore phase. Define the phenomena students experienced in the Engage and Explore phases as "every action has an equal and opposite reaction."

30 minutes

Extend

Continue on to **slide 10** and divide the class into groups of 2–4 students. Distribute one copy of the attached **Design a Helmet** handout to each group.

Tell students that they have been tasked with designing a helmet meant to protect a fragile object. Prior to designing their helmets, they must conduct research on helmet design. Have students research various helmet designs and examine cross-sections of different types of helmets like football, baseball, and bicycle helmets from both the past and the present. Have them take notes on a seperate sheet of paper about the different materials and structures of each helmet. Allow approximately 10–20 minutes for research.

Have groups select a prototype from their research to use as inspiration for an upcoming test drop in which they must design a helmet to protect an egg, apple, or melon as it is dropped from a specified height.

Teacher's Note: Helmet Construction and the Drop

Have students bring common, recyclable materials from home to use in the construction of their helmets. Provide students with eggs, apples, or melons to serve as the “head” that each helmet will protect.

Additionally, select the location and height for the drop. Ensure that the location provides enough height to cause an impact. View the video *Helmet Safety - Cool Science Fair Project* for an example.

Set appropriate timelines for students’ helmet design, test drops, helmet redesigns, and final drops at your discretion.

Display **slide 11**. Have students follow the instructions on the slide and on their Design a Helmet handouts and for drawing and labeling their helmet design. Have students show you their designs for approval. Evaluate each initial design and provide feedback and support if needed.

Have students begin working on building their approved helmet designs in their groups using the materials they brought or any other provided materials.

Once students have finished their helmets, conduct the first test drop. Provide each student with sticky notes and have them offer feedback on each helmet after the drop. Encourage them to record things they liked about the design or suggestions they have to improve the design. Have each group drop their helmets and observe the results.

After the drop, have students read the feedback provided by their classmates and record important points on their Design a Helmet handouts. Allow students time to redesign and rebuild their helmets, then initiate a final test drop. Have students record their results and respond to the final questions on their handouts.

20 minutes

Evaluate

Display **slide 12** and distribute one copy of the attached **PSA** handout to each student. Instruct students to create a Public Service Announcement (PSA) about how to stay safe in the event of a collision. Tell students that they may choose to create a poster, video, or radio announcement for their PSA. Encourage students to choose any type of collision that involves the use of helmets for protection and have them record their ideas on the handouts to indicate the subject of their PSA.

Direct students' attention to the rubric on the second page of the PSA handout. Review the rubric with students and go over each element that they must include in the PSA. Tell them to use the rubric as a guide to create their PSAs. Review or collect students' PSAs upon completion.

Resources

- Cool Science Experiments Headquarters. (2015, August 4). *Balloon rocket science experiment* [Video]. YouTube. https://www.youtube.com/watch?v=DVlf-HwdyTU
- K20 Center. (n.d.). Bell ringers and exit tickets. Strategies. https://learn.k20center.ou.edu/strategy/125
- K20 Center. (n.d.). I notice, I wonder. Strategies. https://learn.k20center.ou.edu/strategy/180
- K20 Center. (n.d.). T-Chart. Strategies. https://learn.k20center.ou.edu/strategy/86
- K20 Center. (2021, September 21). *K20 Center 7 minute timer* [Video]. YouTube. https://www.youtube.com/watch?v=gWwvdLxwV9c
- SpanglerScienceTV. (2011, January 12). *Helmet safety - Cool science fair project* [Video]. YouTube. https://www.youtube.com/watch?v=h7g723Rhuyk
- TODAY. (2017, September 29). *The new football helmet that could save kids from concussions | TODAY* [Video]. YouTube. https://www.youtube.com/watch?v=Aa53zQlnpe4