7th Grade
Motion/Forces Science

Teaching the Science and Engineering Education (SEEd) Standards

UVU College of Engineering & Technology
UTAH VALLEY UNIVERSITY

UVU CREATIVE LEARNING STUDIO

UVU School of Education
UTAH VALLEY UNIVERSITY

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Motion Experience

Grade: 7th

Newton's Third Law - Application

Time: Two 30-45 minute sessions

Utah SEEd Standard

Standard 7.1.2 – Apply Newton's Third Law to **design a solution** to a *problem involving the motion of two colliding objects in a system*. Examples could include collisions between two moving objects or between a moving object and a stationary object.

Lesson Performance Expectations

- Students will work together in a group and each contribute equally to the final project
- Students will construct a guardrail out of various materials to stop a hot wheel car coming down a track.
- Students will record video footage of their projects to play back and analyze as a group.
- Students will complete a worksheet detailing their thought process and answering questions as they do this project.

Materials

- Die cast toy cars, like Hot Wheels (one per student group)
- Hot Wheels tracks (57" track for each student group)
- Track clamp (one per student group)
- iPad (one per student group)
- Popsicle sticks
- Legos
- Pipe cleaners
- Wooden blocks
- Straw constructors
- Mini cinder blocks
- Foam mini blocks

- Interlocking plastic disks
- Scale
- Student desks
- Meter sticks

Vocabulary

- Guardrail - An obstacle that is intended to prevent the event of a serious accident. Usually on a road.
- Predict- To say or estimate that (a specified thing) will happen in the future.
- Iterate - Perform repeatedly, each time improving the action, until success is reached.

Directions

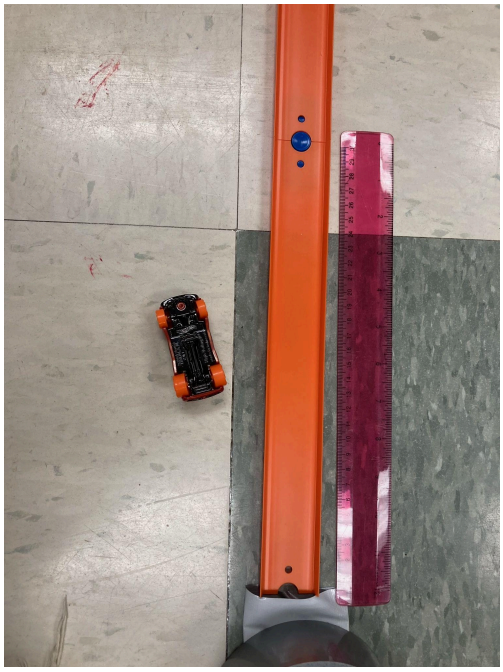
Engage

- Be sure to have eight Hot Wheel tracks and clamps set up before students arrive. Have the duct tape and ruler already in place.
- Use this Google Slides presentation when teaching this lesson. Google Slides Presentation - Newton's Third Law
- Start the lesson out by sharing a short portion of this video showing the effectiveness of guardrails on different sized vehicles: Guardrail Test (Only play from 0:45 to 1:30)
- Share images of different types of guardrails with students that are found in the Google Slides presentation above. Ask the students to think about the structure and the function of each. What makes one type of guardrail work well for bikers, while another guard rail is better for cars? Have students guess the materials that make up one of the guardrails. Why is that material a good choice?
- Let students know that they will be designing a miniature guardrail for a Hot Wheel car.

Explore

- Tell students that they will be working in groups to examine the effect that a toy car has on different guardrail materials.
- Divide students into eight groups. Assign each student group one of the materials: popsicle sticks, legos, pipe cleaners, wooden blocks, straw constructors, mini cinder blocks, mini foam bricks, or interlocking plastic disks.
- Have students make a prediction about which of the in-class materials will be the best for a hot wheel guardrail and record it on their worksheet.
- Have the students get together in their groups and draw a prototype on their worksheets of how they will construct their guardrail with their given materials.

- Each group must make a guardrail out of the assigned materials. The guardrail must be no taller than 5 cm, no wider than 8 cm, and no longer than 15 cm. To watch a video explaining the process, click here.
- Have the students get together in their groups and draw a prototype on how they will construct their guardrail with their given materials.
- Give students about 15-20 minutes to construct their guardrail as a group. They should build their guardrail directly on the duct tape on the floor at the end of the track. This duct tape will have to be replaced after each lesson because it loses its stickiness.
- Students will crash a die cast car into the rail. All tracks should be the same height and length.
    - Students will use the iPads to film collisions in slow-motion. Be sure students hit the record button at least five seconds before releasing the car. Otherwise, their iPad will miss capturing the collision in slow-motion.
    - Students will measure the rebound of the toy car using the ruler and will make note of this data as shown below.



- Student groups will analyze their crash videos in slow motion. What can they learn about the materials they used? Did the materials cause a great distance of rebound? Are the materials able to absorb any of the impact? How do you know?
- Video upload instructions:
    - Once students have finished filming they need to choose the best video (if they have multiple) to show to the class during their presentation. They must **delete** all

their other videos. It's important that they DO NOT delete any other videos from another group. .

- Ipads need to be connected to the cloud before teaching.
- Open up icloud.com
- Sign in with Username: Keggington@uvu.edu Password: SeedPods123
- An authentication code will be sent to one of the ipads. Type in the code on the computer.
- Go to the photo album on the computer. This is where the videos will be uploaded automatically. Each group will come up and show the teacher which video is theirs to present to the class.

Explain

- Each student group will prepare a 2-minute presentation about what they learned. Students should report quantitative data (the measured rebound of their crashes), and their guesses about how the materials affected the crash results.
- Have each group present their findings and videos. Have students take notes on their worksheets.
- Keep a collection of data from all student groups on a whiteboard or poster that can be viewed later.
- Ask the following questions: Are there some materials that are better suited for crashes than others? In real life, do we want a rebound? Why are the materials used for guardrails important and beneficial?

Note: This would be a good place to end day one if lesson is broken up into two days

Elaborate

- Now that students have experimented with one type of material, have each group create a guardrail out of various materials. Students can mix and match materials and consider spacing between the materials. The goal this time is to make a guardrail that absorbs as much of the impact as possible and causes the car to ricochet only a short distance.
- Have students meet together in groups and make a game plan on how they will construct their second guardrail.
- Allow one student from each group to gather a plethora of materials and bring it back to their group.
- Students will test their guardrails by following the same procedures as in the "Explore" phase. Have each group of students use the iPads to collect video data again.

Evaluate

- Each student group will prepare another 2-minute presentation about what they learned from their "Elaborate" tests.
- Have each group share their findings and record the new data on the board.

- Ask the class what they think the overall best material or combination of materials was in this situation. Ask the following questions: How did you see Newton's Third Law in this lab? Did every car have a rebound?
- Have students finish filling out their worksheets and turn them in.

Appendix B:

- Video instructions for constructing the hot wheel track: _____
- Video instructions for filming the car crash in slow motion:_____
- Google Slides presentation for this lesson: Newton's Third Law Presentation

7th Motion Inventory List

Lesson 1: *7.1.2.* - Motion

Tote 1:

- 9 blue and orange track clamps
- 230 wooden blocks (110-120 per container)
- 500 popsicle sticks
- 1 bag of legos
- 1 bag of pipe cleaners
- 1 bag of square wooden blocks
- Orange bag of straw constructors
- Approx. 50 mini cinder blocks
- Tub of interlocking plastic disks
- iPads (the number will depend on students in class)

Tote 2:

- 7 die cast toy Hot Wheels cars
- 100 long orange hot wheels tracks
- 70 blue hot wheels connector pieces
- 285 foam mini bricks
- 3 rolls of duct tape

Newton's Third Law Worksheet

Grade: 7th

Designing the best guardrail for Hot Wheels cars

Define

Look at pictures of different types of guardrails.

What is the structure and function of each guardrail?

What makes one guardrail work better for bikers while others work better for cars?

What materials are the guardrails made of?

Why are these materials good choices?

Predict

Write down the material your group has been assigned to work with today.

Do you think this material will make an effective guardrail? Why or why not?
Do you think this material will cause much rebound? Why or why not?

Brainstorm

Draw a simple model(s) of how you'll construct your guardrail

Select: If you drew multiple models, pick the one you think will work best and circle it

Gather Data

With your team, you will be constructing a guardrail to crash a toy car into.

Your guardrail can be no **taller** than **5 cm**.
Your guardrail can be no **wider** than **8 cm.**
Your guardrail can be no **longer** than **15 cm**.

You will build your guardrail at the end of the track on duct tape. You will place a meter stick by the side of your tack, so you can measure the rebound of the toy car.

Once you have the track, guardrail, and meter stick in place you must show the teacher. Once the teacher checks off on your track, you will be given an iPad.

You will record your car going down the track in slow-motion and running into your guardrail. Be sure to set your iPad to Slow-Mo. Press the record button and count to five before releasing the car down the track.

Record the distance of the rebound. Watch your video and record your answers in the table below.

Material assigned for your guardrail: _____

Observations:	Rebound Distance (cm):

Analyze

Each group will share their data with the whole class. Please fill out the data table below with the information that is shared.

Material Used	Rebound	Guess as to why

Please answer the following questions after all data has been shared.

Which material caused the greatest distance of rebound?

Which material was able to absorb the impact the most? How do you know?

Why do you think some materials worked better than others?

Communicate

What would you do differently next time?

Draw a prototype for a new guardrail using <u>any</u> materials and the information you've learned today: