

How Do NASCAR Race Cars Come to a Stop After Moving at Speeds Over 200 MPH?

Grade Level	Topic	NGSS
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MS

Force and Motion

PS3.A

Phenomenon

A car moving at 30 mph. requires 75 ft. to stop. A car moving at 60 mph. requires 240 ft. to stop. Doubling the speed of a moving object doesn't double the amount of time it takes for the object to stop.

Materials

- Toy cars, marbles, tennis balls, cylindrical blocks, and other rollable objects;
- Cardboard or other ramp materials;
- Books or blocks to prop up the ramp; and
- Small wooden blocks.

Material Management Tips

- Make sure videos are ready and queued at the proper timestamp.
- Have materials ready for students in a container.

SCIENCE AND ENGINEERING PRACTICE(S)

Constructing Explanations

Use evidence (e.g., measurements, observations, patterns) to construct an explanation.

DISCIPLINARY CORE IDEAS

Targeted Science Ideas and Engineering Ideas (when applicable)

PS3.A

Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed.

CROSSCUTTING CONCEPTS

Energy and Matter

Energy can be transferred in various ways and between objects.

Safety

NSTA encourages K-12 teachers and school leaders to promote and support the use of science activities in science instruction and work to avoid and reduce injury. Additionally, NSTA recommends teachers and school leaders visit the [NSTA Safety Resource](#) page for up-to-date information on safety issues and guidelines.

SUPPORTING EQUITABLE PARTICIPATION

Interactions



One-to-one



One-to-small group



One-to-many



Small group-to-many

Modalities

How students communicate their ideas

Talk • Text • Visual: Drawing, Symbols, Table, Graph, Chart, and Gesture

EXPERIENCE PHENOMENON

Students experience the phenomenon or problem. The teacher creates an **opportunity for students to connect** with this specific event or problem [through prior experience, interests, and curiosities] and **raise or identify a student question** to investigate.

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What is the teacher doing to support students' sensemaking?

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What are students doing to make sense of the phenomenon? [Includes teacher look-fors]

1. Introduce the Phenomenon

Tell students you made an interesting observation the other day and you want to share it with them. Show students the demonstration setup and ask them to make some observations.

Set up a ramp in your classroom. Mark the halfway point up the ramp, and mark the top. Select an object that rolls, place it on the halfway point, and allow it to roll down the ramp and across the table or floor. Use a small piece of tape or an adhesive note to mark where the object stops.

Return the object to the ramp, but this time, place it on the top of the ramp. Before you roll the object, ask students to predict how much farther the object will go now that the object is twice the distance away and likely will be traveling at about twice the speed as before. Expected responses include these:

- A lot farther;
- Twice as far;
- Farther, but not quite twice as far; and
- The same distance.

Students participate in a live demonstration to figure out some things about the relationship between speed and energy. Based on the demonstration, students make a prediction about how far the object might travel if it were placed at a higher starting point on the ramp.

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Probe their thinking a little to get a general sense of the class's thinking. Some suggestions include

- Did anyone else have that idea?
- Does anyone have a different idea?
- Can someone with a similar idea restate ____'s idea?

Use this demonstration and discussion as a formative assessment opportunity to assess students' prior learning and background knowledge about energy and indicators of energy.

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After a minute or two of discussion, roll the object and mark the new stopping location. The object will roll more than twice the distance as the original. Say, "That's curious, isn't it? Most of us expected the object to roll twice as far, but it didn't. It rolled much farther." Ask students to turn and talk to a partner to share ideas about why the object rolled so much farther. Have students share their ideas with the class. Ideas here will vary, but focus on ideas that have to do with the object having more energy at the top of the ramp, so it rolled farther.

Students talk with a partner about the investigation results, then share with the class.

Next, ask students what they think would happen if this wooden block was placed in the path of the moving object. Have them turn and talk with a neighbor about what they might see. Tell students that when they have an idea, they should draw a model of what they might see happen to both the block and the moving object. Expected responses include these:

- The object will push the block.
- The moving object will bounce off the block, but the block won't move.
- The block will move forward, and the object will go backward after it hits the block.

Students brainstorm ideas, then make a model of their ideas for the moving block.

Roll the object from the midway point as students make observations.

Students make observations and add to their model to develop an initial explanation using energy and begin to relate energy to speed.

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Ask, “I wonder if that’s how it always works? If we double the speed of anything, will it always have the energy to go more than twice as far or push something twice as far? What could we do if we wanted to investigate that?” Expect students to mention the need to roll different kinds of objects to test the idea. Some may share experiences about riding bikes, skateboards, etc., which is encouraged to broaden the phenomena outside the classroom.

Ask students to brainstorm a list of things they have rolled, rolled on, or watched roll. From that list, choose a few to test in the classroom.

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Students use the related phenomena to build connections to the lesson question.

INVESTIGATE

Students engage in the practices of scientists and engineers to build understanding of targeted science ideas [and engineering ideas] needed to explain the phenomenon or solve the problem.

Divide students into groups of 3–5. Either provide 2–3 rolling objects or allow the groups to self-select from a collection. Students will set up a ramp and test each object by rolling it from the middle and top of the ramp. For each object, they record relative data about how far each object rolls after reaching the end of the ramp and how far the object moves a block placed in the way. Note that there is no need for exact measurements unless you wish to make them. Relative measurements like “twice as far, less than twice as far, more than twice as far” are enough to draw conclusions.

Students conduct an investigation to determine if doubling the speed of an object always doubles (or more) its energy by observing distance traveled and distance a block is pushed.



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REFLECT

Students use the new or revised science ideas they developed to help explain how or why the phenomenon occurs and/or to identify solutions to the problem.

2. Whole-Class Discussion

When the investigation is complete, present students with three statements and ask them to choose the one they have evidence for.

1. Doubling the speed of the object always more than doubled the energy.
2. Doubling the speed of an object almost always more than doubled the energy.
3. Doubling the speed of an object never more than doubled the energy.

Students select one of three statements to use as evidence. Student groups discuss their choice, and a volunteer from the group will share their main ideas.

Allow students to group themselves by their response choice and share the evidence they used to make their choice. Solicit one volunteer from each group to share their group's main ideas.

Share with students that you were wondering whether the same would hold true for large mechanical objects like cars, trucks, and motorcycles. Say, "I found some data for cars using specific numbers. Does this data match your ideas?" Share that, on average, it takes a car moving 30 mph about 75 ft. to stop and a car moving 60 mph about 240 ft. to stop. How far do you think it would take the fastest cars, like NASCAR race cars traveling at 200 mph., to stop? We know they don't like to stop, but what if they had to, for example, have a pit stop to change tires and get more fuel?

Students watch a video about NASCAR pit stops.

Share [NASCAR Pit Stop](#) video with students.

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Build a connection between the students' experiments and a stopping car. Revisit students' initial ideas about why the block stops the rolling objects, focusing on the block sliding across the table (friction). Point out that cars use brakes to stop, which is a little different, but still involves two surfaces rubbing against each other. How do brakes transfer and/or transform all that motion energy?

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Students make a connection between the investigation they did during the lesson and the car in the video stopping.

Show the following video: <https://twitter.com/i/status/1416905160304074759> and ask students what they see when looking at the brakes of this car. Share the first image on this page for a closer look. <https://www.brembo.com/en/company/news/6-things-no-one-ever-told-you-about-nascar-cup-series-brakes>

Students watch another set of videos and are prompted to think about energy transformations.

Students may wonder why they didn't notice the objects they used in their own experiments getting warmer. If so, expand their thinking by asking about the connection between speed and energy. Ask students to experience the connection between speed and energy by rubbing their palms together? Why did they feel their hands getting warmer when the objects they investigated did not?

This lesson could be one in a series of lessons building toward the following:

MS-PS3-1—Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.

[Clarification Statement: Emphasis is on descriptive relationships between kinetic energy and mass separately from kinetic energy and speed. Examples could include riding a bicycle at different speeds, rolling different-sized rocks down a hill, and getting hit by a wiffle ball versus a tennis ball.]

AT THE RACE TRACK

Watch for glowing brakes!

Where on the track do the cars need to slow down (lose energy) or speed up (gain energy)? Is there a pattern to where speed changes occur? Additionally, watch the pit row where the teams of mechanics and engineers support the drivers. How fast does the car enter and leave the pit? How much distance does it take for it to stop?

