How Does Being Close to the Ground Help a NASCAR Race Car?

Grade Level  | Topic  | NGSS  
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MS | Properties of Materials | PS2.A

**Phenomenon**
Cars and their distance to the ground

**Materials**
- Pictures of Cars
  - Example 1
  - Example 2
- Graphic and Article: “NASCAR’s Goldilocks Problem: How Much Downforce Is ‘Just Right’?”

**Material Management Tips**
- May want to have colored pictures printed of the cars available for students.
- Print pictures of the graph for students to write on individually or in groups.

**SCIENCE AND ENGINEERING PRACTICE(S)**
- Analyze and Interpret Data
  - Analyze and interpret data to provide evidence for phenomena.

**DISCIPLINARY CORE IDEAS**
- PS2.A Forces and Motion.
  - The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change.

**CROSSCUTTING CONCEPTS**
- Cause and Effect
  - Cause-and-effect relationships may be used to predict phenomena in natural or designed systems.

**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*
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.

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.

1. Introduce the Phenomenon

Why could being so close to the ground help a NASCAR race car?

Students watch the video to gain a shared understanding of NASCAR racing.

Present students with the two pictures (below) and inform students that both of these cars are Camaros. Tell students that the red car is one you could buy at a car dealership and the other is a race car for NASCAR. Ask students to look for similarities and differences between the two cars. Give students a few minutes to make some observations, then share what they notice with a shoulder partner. Next, have students share their observations with the whole class; as they share, record their noticings on the board.

Example 1

Example 2
After each pair has shared a similarity or difference, focus on the difference in distance between the car and the ground between the two cars. Say, “Many of you pointed out that the race car is much closer to the ground than the car you would buy at a dealership. What ideas do you have about why there might be such a difference?”

In small groups, have students brainstorm ideas of why the NASCAR race car might be so close to the ground. Allow each group to share their ideas. Student ideas could include these:

- So nothing can get under it;
- Because it makes the car go faster;
- So air doesn’t get under the car; and
- Because the engine is bigger, so it’s to cover it up.

Answers here will vary, but capitalize on ideas related to air getting under the car. If this idea did not surface, focus on ideas connected with “things” getting under the car, then facilitate a discussion that will lead students to the idea of air. For example, prompt students to think about all the different kinds of things that could get under the race car: debris from the stands and other cars, dirt, and air. If air still doesn’t surface in the discussion, ask students, “Are there things that can get under the car that we know are there, but cannot see?”

Ask students, “Could keeping air from getting under the car really be the reason these cars are so close to the ground?” Use the thumbs-up/thumbs-down protocol to poll students to see if they agree or disagree with the question.

Have each group of students confer for 3 minutes, then have each group state why they agree or disagree with the statement “Could keeping air from getting under the car really be the reason the race cars are so close to the ground?”

Students take a side—“yes” or “no”—about the idea of air being the reason the cars are so low to the ground.

Students discuss their evidence and/or reasoning for this idea and share.

Use student ideas to motivate the need to figure out more about air and the distance between the ground and the car.
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.

Next, show students the following graph from the article “NASCAR’s Goldilocks Problem: How Much Downforce Is ‘Just Right’?”

In groups, have students engage in the I2 strategy (what I see, what I think it means) to help them analyze and interpret the graph. If you are unfamiliar with this strategy, tell students to circle (or identify in some way) what they see, then have them record what they think it means.

When student groups finish, have them share what they circled (“what I see”), and ask them to explain in their own words what they think it means. Students should notice the following:

- One axis has speed: It means how fast the car is moving.
- The other axis has downforce. This will vary, but they think it has to do with how much force is pushing down on the car. Some students may describe it as how much “gravity” is on the car.
- One line goes straight across the graph at 3500. It means that this line doesn’t change, and they think the 3500 might be the weight of the car, since it is measured in pounds.
- The other line trends (goes) up. It means this line is related to speed because it goes up when the speed goes up.
Now that students have pulled some information from the graph, ask them what questions they have. Common questions include these:

- What is downforce?
- How can some downforce be constant (stay the same)?
- Why does some downforce seem to be connected to speed?
- Is downforce connected to the shape of the car?

To answer some of their questions, have students read the first section of this article about downforce: “NASCAR’s Goldilocks Problem: How Much Downforce Is ‘Just Right’?”

Students only need to read the section titled The Problem. Have students read the section individually; while they read, have them highlight any information they think is important in answering their questions about the graph and/or the questions about why the race cars might be so close to the ground. Next, have students re-read the section and use a different highlighter color to indicate where they have questions about the information.

Have students share what they highlighted with a partner or in small groups, then facilitate a whole-class discussion to summarize what students have learned from the article. Students should share that

- Mechanical downforce does not change because it is the weight of the car pushing the car down.
- Mechanical downforce would only change if the weight of the car changes.
- Aerodynamic downforce does change, and it changes when the speed of the car changes.
- Aerodynamic downforce is the force of the air pushing the car to the track.
- Downforce pushes the car tires to the track.
- Downforce lets the car tires grip the track better.

Students ask questions about the graph.

Students read a small section of the article “NASCAR’s Goldilocks Problem: How Much Downforce Is ‘Just Right’?” to help them understand more about the information in the graph. Students use a close reading strategy to help them identify important information in the article and information they have questions about.

Students share what they highlighted with a partner or in small groups.
If students are not familiar with the term aerodynamics, explain that aerodynamics is the study of moving air and how it interacts with objects.

Once all the information is summarized, ask students what questions they still have. Student questions will vary, but should include questions about how moving air can force a car to stick to the track. Say to students, “What I hear you saying is that you know air moving across the car increases the downforce, but we are not sure why, is that right?”

Circle back to the pictures of the car that were introduced at the beginning of the lesson. Have students work in small groups to brainstorm ideas about how the shape of the car might help increase the aerodynamic downforce. Tell students it might help them if they develop a model that includes where the air would go.

As you walk around, ensure students are making connections between the amount of air that can go under the different cars and the relationship between the speed of the car and the increase in aerodynamic downforce.

When students have finished recording their ideas, have students engage in a gallery walk using the “one-stay, three-stray” protocol to look for ideas that are similar and different. If you are not familiar with this strategy, it is when one group member stays to answer questions and the other group members move on to look at the other groups’ ideas.

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.

After groups have identified similarities and differences among all the models, engage students in a whole-class discussion to develop a class consensus model that better explains how aerodynamics affects downforce. To facilitate this discussion, ask students to list all of the components our model should include; students should respond with these statements:
• Two cars, one that is close to the ground (NASCAR car) and a regular car that you could buy;
• Air and a way to represent air molecules and their movement (like dots with arrows);
• The idea that more air could go under the regular air, with less air going over the top; and
• Less air can go under the NASCAR car, which forces more air to go over the car.

At this grade level, students should know that air is a gas that has weight (mass) and takes up space. If students do not have this prior knowledge, consider including an activity that demonstrates this science idea.

Now that students have a better idea of how the shape of the car can affect how air flows around the car, have students work in small groups to develop an explanation for the relationship between the speed of the car and the downforce. Have students reference the class model and use evidence from the data table as evidence.

Explanations will vary, but should include the idea that the faster the car is moving, the more air moves up and over the car, and since more air is moving up and over the car, more weight is pushing it down on it. As shown in the data table, as the speed increased, so did the aerodynamic downforce because more air is moving up and over the car.
Is slower safer?

As you are watching the race, look for what happens when cars slow down. Pay close attention to what is happening with the air around the cars when they enter or exit pit road.

- What types of objects at the track are made of metal? How does the shape of the metal help the function of the object?
- What types of objects might have foam inside? How does foam inside an object help the function of the object?
- What types of objects are made of rubber? How does the shape of the rubber help the function of the object?