Sponsored Educational Materials

SCHOLASTIC

STEM LESSON PLANS

GRADES 5–7

TEACHING GUIDE

UNIT 1: *AERODYNAMICS*

UNIT 2: *ENERGY*

NEW LESSONS!

Dear Teacher,

Science is all around us!

STEM is serious business on a NASCAR racetrack, where race cars can reach speeds of more than 200 miles per hour. The **NASCAR Acceleration Nation** program brings STEM skills to life in the classroom with two units full of fun, hands-on experiments that teach students in grades 5–7 about key scientific principles.

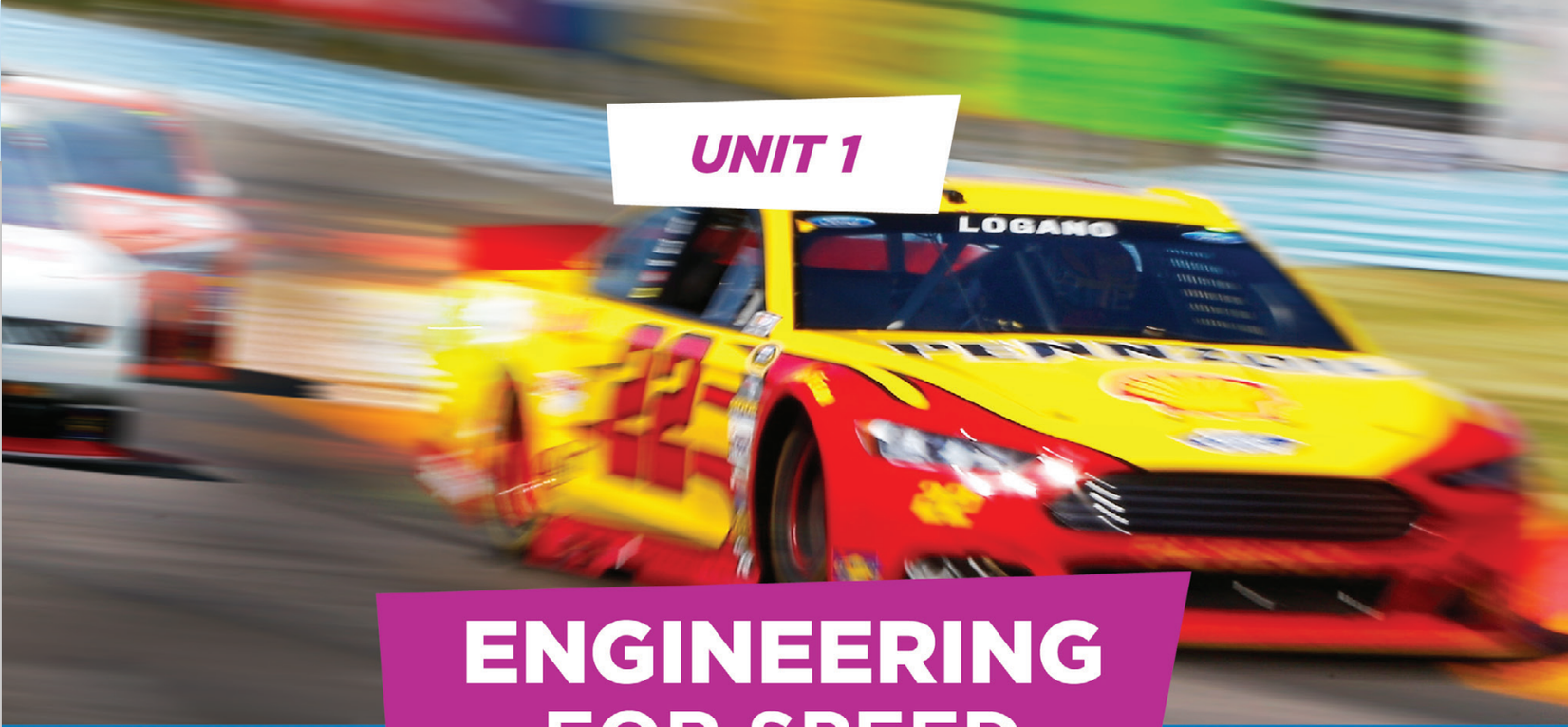
- **UNIT 1—Aerodynamics:** Five interactive lessons about **aero balance** and the key aerodynamic principles known as **drag, downforce,** and **drafting**. Plus a brand-new online car engineering simulation at **scholastic.com/nascarspeed.**
- **UNIT 2—Energy:** Three engaging lessons that demonstrate how **potential energy, kinetic energy,** and **friction** influence NASCAR and the world around us.

Ready to teach your students all about the science of speed? Buckle up, and let's go!

CONTENTS

UNIT 1: AERODYNAMICS

UNIT 2: ENERGY AND NASCAR



UNIT 1

ENGINEERING FOR SPEED

DRAG • DOWNFORCE • DRAFTING • AERO BALANCE

★ AERODYNAMICS LEARNING OUTCOMES ★

LESSON 1: DRAG
START YOUR ENGINES

At the end of Lesson 1, students will be able to:

1. **Define the science of aerodynamics**
2. **Explain how drag influences moving objects**
3. **Identify the elements of a race car that create drag**

LESSON 2: DOWNFORCE
UNDER PRESSURE

At the end of Lesson 2, students will be able to:

1. **Explain how air pressure influences moving objects**
2. **Identify how the speed of air determines the amount of pressure moving air exerts**
3. **Determine which combinations of air pressure create downforce and lift**

LESSON 3: AERO BALANCE
BALANCE IN ACTION

At the end of Lesson 3, students will be able to:

1. **Define aerodynamic balance**
2. **Explain why aerodynamic balance is important to race car engineers**

LESSON 4: ENGINEERING AERO BALANCE
KEEP IT BALANCED

At the end of Lesson 4, students will be able to:

1. **Identify factors that affect a race car's aerodynamic balance**
2. **Provide solutions to fix an aerodynamically imbalanced race car**

LESSON 5: DRAFTING
GAME CHANGER

At the end of Lesson 5, students will be able to:

1. **Define the strategy of drafting**
2. **Explain how aerodynamics principles help drafting cars move faster**

NEW ONLINE SIMULATION

Go digital with the new **Design + Drive Simulation**. Students will be able to apply aerodynamics principles to design, then drive their own race cars at **scholastic.com/nascarspeed**!

BEFORE YOU BEGIN Have students complete the pre-assessment on page 2.

PRE-ASSESSMENT ANSWER KEY **1.** C; **2.** B; **3.** A; **4.** C; **5.** A; **6.** A; **7.** B; **8.** B; **9.** E; **10.** D

NAME _____

DO YOU KNOW THE SCIENCE OF SPEED?

This unit is about aerodynamics and how it influences force, momentum, and speed. Share what you know about the science of speed.

1 What does the science of aerodynamics study?

- **A** The weight of objects
- **B** The speed and flight of objects
- **C** The movement of air
- **D** The sound of air

2 What are three key aerodynamics principles?

- **A** Drag, height, and acceleration
- **B** Drag, downforce, and drafting
- **C** Acceleration, downforce, and motion
- **D** Acceleration, height, and motion

3 What word describes a force that slows an object when air pushes against it?

- **A** Drag
- **B** Downforce
- **C** Drafting
- **D** Deceleration

4 What aerodynamics force is used to create both lift and downforce?

- **A** Air speed
- **B** Air pressure
- **C** Both A and B
- **D** Neither A nor B

5 A race car is aerodynamically balanced when there is balanced force on:

- **A** The front and back wheels
- **B** The spoiler and the roof
- **C** The splitter and the rear bumper
- **D** None of the above

6 True or false? Downforce is the opposite of lift.

- **A** True
- **B** False

7 True or false? Aerodynamic balance is complicated, which makes it impossible for engineers to use it to improve a race car's performance.

- **A** True
- **B** False

8 Drafting happens when:

- **A** Two or more race cars accelerate next to each other with inches between them.
- **B** Two or more race cars line up, one behind the other, with inches between them.
- **C** Two or more race cars tap the bumpers of the cars in front of them.
- **D** None of the above

9 The goal of adaptations to NASCAR race cars is:

- **A** To prevent race cars from flipping over or lifting.
- **B** To provide more downforce to improve tire traction.
- **C** To force high-pressure air over the car to make sure it "sticks" to the track.
- **D** To create more contact between the tires and the track.
- **E** All of the above

10 Why is the science of aerodynamics important to racing?

- **A** Aerodynamics helps improve the safety of the race cars, keeping them on the track.
- **B** Aerodynamics enhances the speed of the race cars, helping drivers zoom past the competition.
- **C** Aerodynamics helps improve the performance of the cars, keeping them running smoothly and consistently.
- **D** All of the above

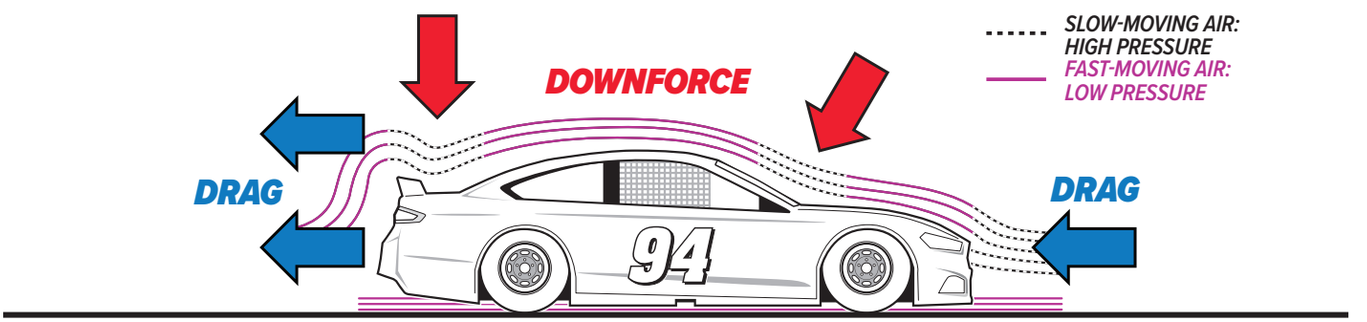
LESSON PLAN 1: DRAG
START YOUR ENGINES

TIME REQUIRED 1½ hours, plus time for optional extension activity

MATERIALS Recycled or reused paper (2 sheets), race car templates (1 per student), card stock (1 sheet per student), scissors, tape, markers, wheels (4 per student), axles (2 per student), index cards (1 per student), ruler, plastic straw (1 per student). *Note: Test that the axles fit in the opening of the straws before the lesson. After the Drag activity, save the leftover piece of straw and the card stock for Lesson 2.*

ACTIVITY AND RESOURCE SHEETS Assembly Sheet A, Activity Sheet 1: Drag, Resource Sheet A, Resource Sheet B. **Download additional sheets as needed at scholastic.com/nascarspeed.**

VIDEOS View *Aerodynamics on the Racetrack* and *Drag* at **scholastic.com/nascarspeed.**



THINK

What is the science of aerodynamics?

Introduce **aerodynamics**—the study of the movement of air, specifically how it flows around objects such as cars and airplanes. Explain that NASCAR engineers study aerodynamics to improve the speed and safety of race cars.

Show the Video

Introduce the unit by showing students *Aerodynamics on the Racetrack* at **scholastic.com/nascarspeed**.

MOVE

How does the science of aerodynamics work?

1. Call on three volunteers. Have one student drop a flat sheet of paper from about 3 feet up, while another times how long it takes to hit the floor.
2. Have the third volunteer crumple the paper into a ball and repeat the experiment. Ask students to explain what happened. Note that the object's shape affected how it moved through the air. The flat sheet of paper met resistance and moved slowly. Crumpling the paper into a ball reduced its surface area and caused it to drop more quickly to the ground.
3. Explain that aerodynamics doesn't apply only to objects. Ask students if they can think of sports in which people might bend to give their bodies less surface area or spread their bodies to make more surface area. You may show images of downhill skiers and speed skaters (smaller surface area); skydivers and hang gliders (larger surface area). Ask: *Why might speed be desired in some sports and moving more slowly be desired in others?*

BUILD

What is drag?

1. Point out that NASCAR engineers not only make cars super fast—they also make them safer. Explain that **drag**, or air resistance, is a force that occurs when air pushes against an object as it moves, slowing it down.

Show the Video

Show students *Drag* at **scholastic.com/nascarspeed**.

2. Pair students into pit crews of two. Hand out the car templates, *Assembly Sheet A,* and *Activity Sheet 1: Drag*. Have students assemble the cars and complete the experiment. You can print out more car templates as needed using the template provided at **scholastic.com/nascarspeed**.
3. Hand out *Resource Sheet A* to support groups in answering the Conclusions questions. To wrap up, explain that much like the index card in the experiment, the spoilers on NASCAR race cars create drag to slow them down and make them safer to operate.

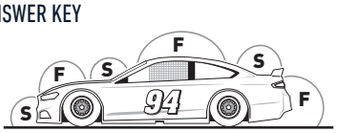
EXTENSION: PIT CREW CHALLENGE

TEAM UP

How does a race car's design make it more aerodynamic?

1. Give each group a copy of *Resource Sheet B*. Instruct students to read the introduction, then mark three areas where air moves slowly around the car with an "S" for slow-moving air; and mark three areas where air moves quickly around the car with an "F" for fast-moving air.

ANSWER KEY



2. To wrap up, challenge each group to write an explanation of how one of the features labeled on *Resource Sheet A* increases or decreases drag.

ASSEMBLY SHEET A

BUILD A RACE CAR

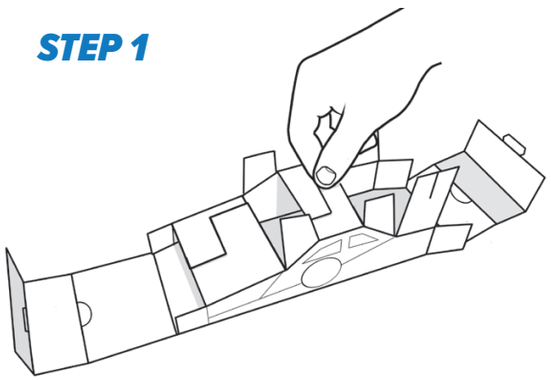
GATHER YOUR MATERIALS

Car template, plastic straw, scissors, ruler, four round candies with holes in their centers, tape, markers

BEFORE YOU BEGIN

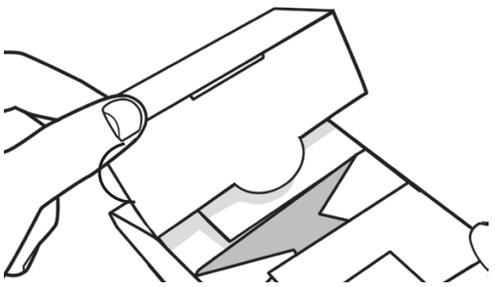
Color or personalize your race car.

STEP 1



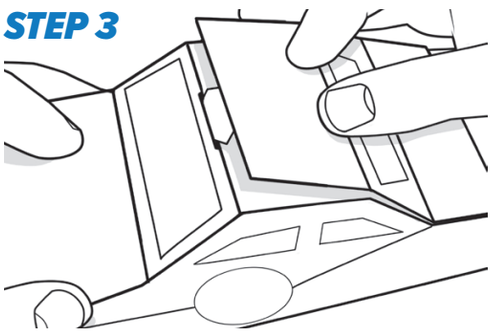
Flip the car over. Fold up the sides and connect the tabs using the split ends.

STEP 2



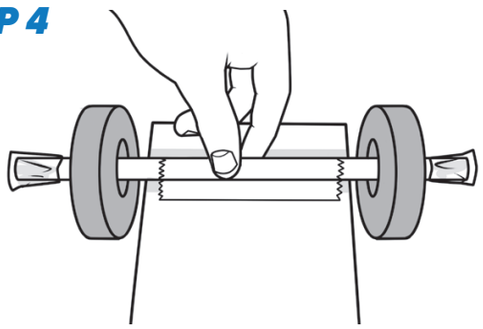
Fold up the front and the back of the car to cover all the tabs. Secure the hood and trunk by tucking the semicircles into the front and back openings.

STEP 3

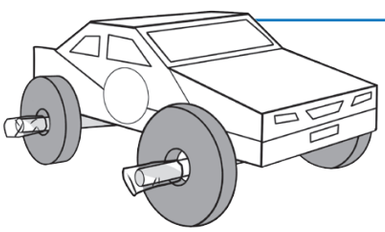


Connect the front and back of the car by sliding the top tab into the top slot. Reinforce the roof of your car with tape.

STEP 4



Cut two 3-inch pieces from the plastic straw. *(Note: Save the final piece of straw for the Lesson 2 experiment.)* Flip the car over and tape the straw pieces along the guidelines on the bottom of the car.



COMPLETE YOUR CAR

Thread a candy over each straw end. Fold a small piece of tape over the end of each straw to keep the candies in place. (Note: The tape shouldn't prevent the candies from spinning.) **Now your car is ready to roll.**

NAME _____

START YOUR ENGINES

What limits how fast a race car can go?

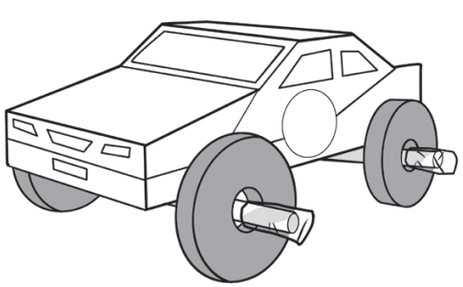
One factor is **drag**—a slowing force created when air pushes against an object. Try this activity to test how drag affects motion.

GATHER YOUR MATERIALS

Completed car, ruler, tape, index card, card stock

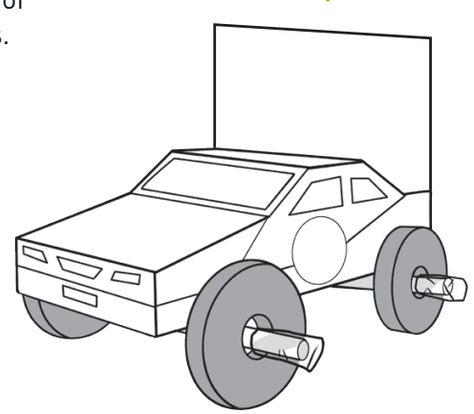
PROCEDURE

1. Fold up both edges of a sheet of card stock. Lift one end of the card stock onto a stack of books to form a ramp.
2. Place your car at the top of your ramp so that it rolls forward. Measure the distance it travels. Repeat for a second test run. Record both results.
3. Tape an index card to the back of your car so that it sticks up above the car's roof. Repeat Step 2 again for two more test runs. Record the results of both runs.



DISTANCE TRAVELED
RACE CAR WITHOUT INDEX CARD

Test Run 1	Test Run 2



DISTANCE TRAVELED
RACE CAR WITH INDEX CARD

Test Run 1	Test Run 2

CONCLUSIONS

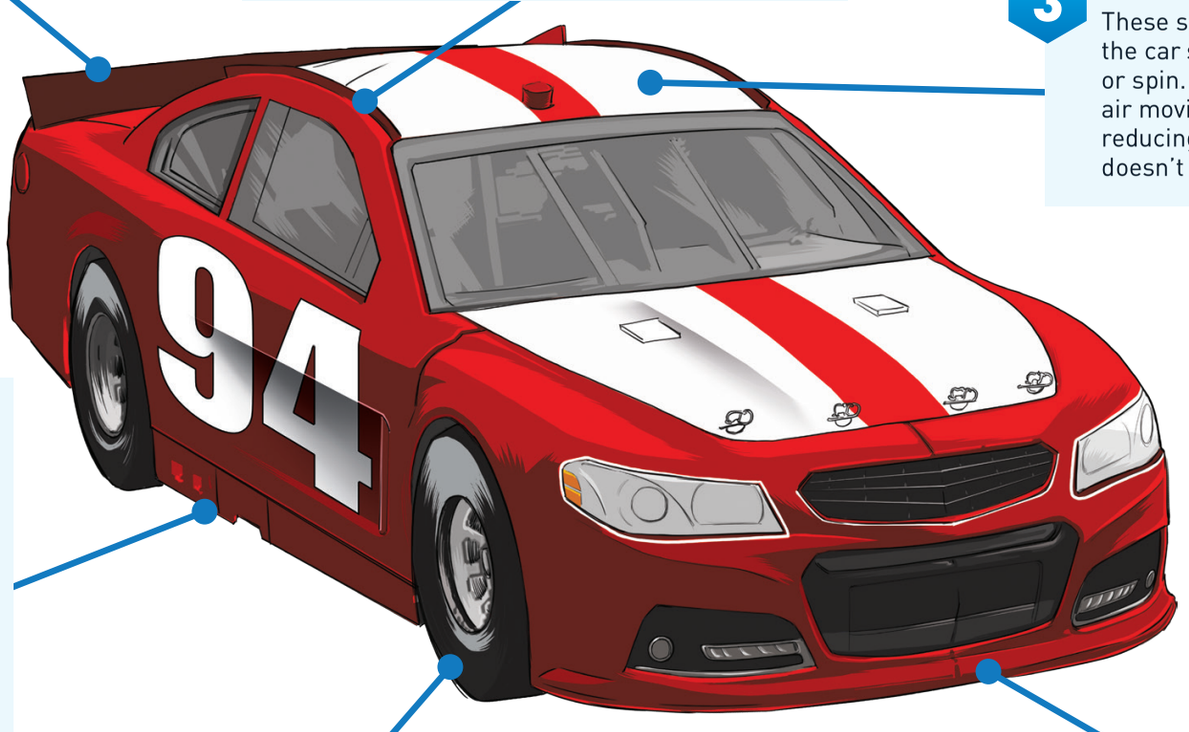
Answer these questions on a separate sheet of paper.

1. Which car went farther? Explain why you think this happened.
2. How did adding the index card affect the car's drag?
3. Why might NASCAR engineers modify race cars to create the type of drag your race car experienced? Look at *Resource Sheet A* for clues.

RESOURCE SHEET A

RACE CAR ADAPTATIONS

Each racing season, NASCAR sets rules that determine the shape and weight of its cars. Check out some NASCAR race car features and learn how they influence safety, speed, and racing aerodynamics.



1 SPOILER

This device traps high-pressure air, creating downforce to provide more rear-tire traction. It also increases drag to prevent race cars from traveling at unsafe speeds.

2 ROOF STRIPS

These thin rails run along the roof edges to disrupt airflow and cut down on unwanted lift.

3 ROOF FLAPS

These spring open if the car starts to slide or spin. They disturb air moving over the car, reducing lift so the car doesn't go airborne.

4 SKIRTING

Edging around the bottom of the car prevents high-pressure air from moving under the vehicle and creating unwanted lift. If the car starts to slide sideways, the skirting lessens the chance of the car rolling over or flying off the track.

5 TIRES

Treadless tires make more contact with the ground, increasing traction.

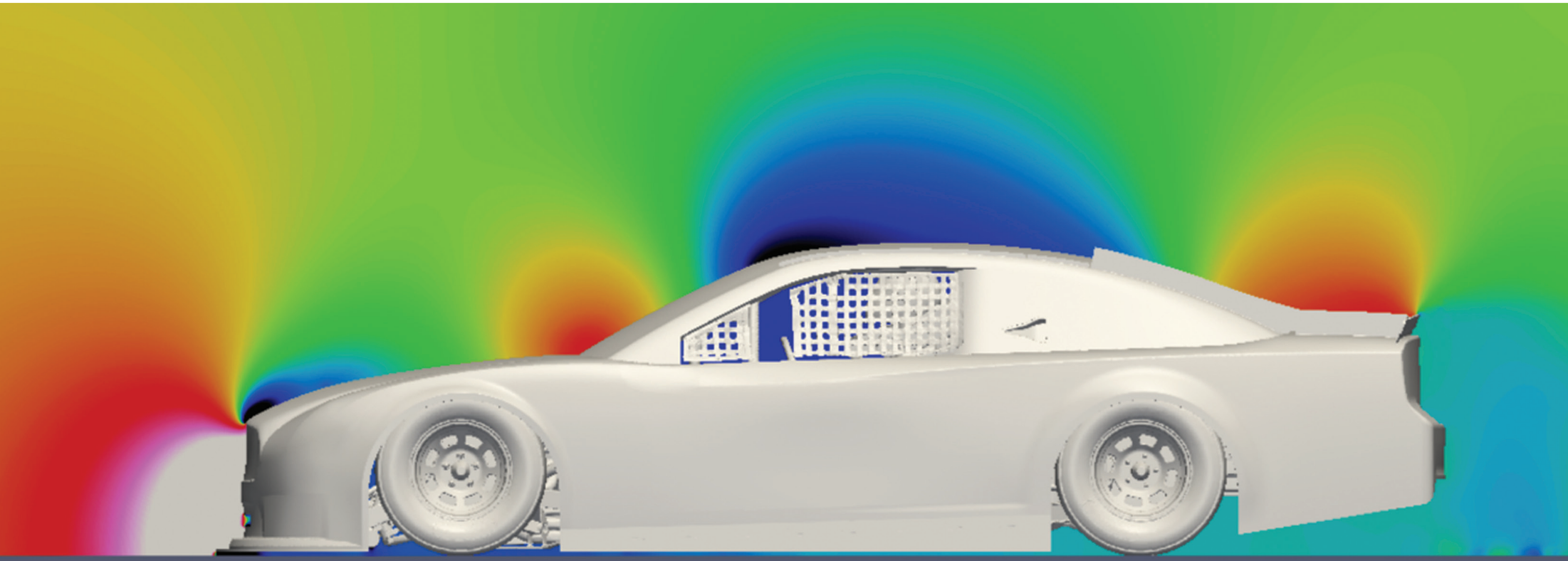
6 SPLITTER

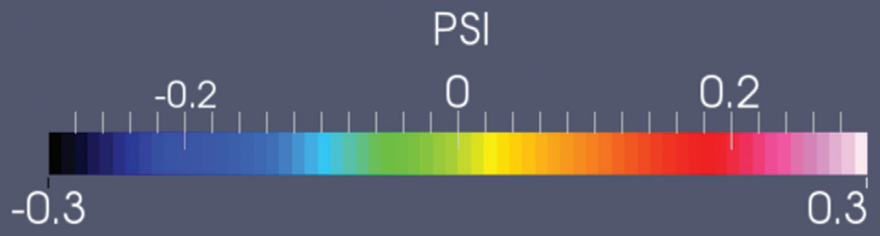
This flat strip runs parallel to the ground underneath the front bumper. Air accelerates more quickly under the splitter, leading to a low-pressure area that helps suck the car downward toward the track.

RESOURCE SHEET B

RACE CAR AIRFLOW

The way air flows around a NASCAR race car determines how much pressure the car is under. Pressure is measured by PSI, which means pounds per square inch. Areas that allow the air to flow quickly experience low pressure. Areas where the air gets trapped and flows slowly experience high pressure.





Use the color bar above to identify the areas of the car that experience the highest pressure and the lowest pressure.

LESSON PLAN 2: DOWNFORCE
UNDER PRESSURE

TIME REQUIRED 45 minutes, plus optional extension activity

MATERIALS Recycled or reused paper (1 sheet per student), straws (1 per student), spools (1 per student), index cards(1 per student), card stock (1 sheet per student), rulers, scissors, pencils, markers, completed cars. *Note: Students will need one whole straw, plus the piece of straw left over from Lesson 1. Students will reuse the card stock from Lesson 1.*

ACTIVITY AND RESOURCE SHEETS Assembly Sheet B, Activity Sheet 2: Downforce, Resource Sheet A, Resource Sheet C (optional). **Download additional sheets as needed at scholastic.com/nascarspeed.**

THINK

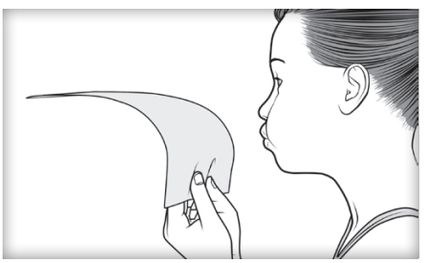
How are the aerodynamics of racing and flight similar?

1. Explain that because NASCAR race cars can reach speeds of more than 200 miles per hour, they rely on air pressure and special race car adaptations to stick to the track. Air pressure—a key element of aerodynamics—is a force caused by the weight of air molecules pushing against an object's surface.
2. Fast-moving air causes low air pressure, and slow-moving air creates high air pressure. **Downforce** is created when high pressure pushes down on an object from above and there is low pressure below. **Lift**—the opposite of downforce—is created when there is low pressure above an object and high pressure below.
3. Downforce pushes NASCAR race cars downward so they stay on the track. Lift pushes the wings of airplanes upward so that the planes fly.

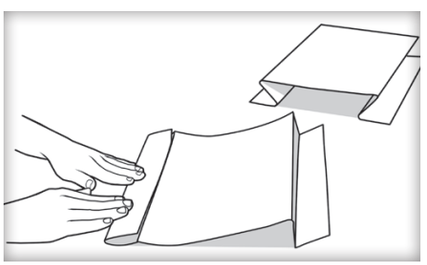
MOVE

How does air pressure cause an object to rise or fall?

1. To demonstrate how air pressure works, have each student hold the short end of a sheet of paper with his or her hands pointing up. The paper should curve down over the back of his or her hands. Tell the students to blow forcefully over the curve of the paper. What happens? *(Faster-moving air over the top of the paper creates lower pressure above in contrast to higher pressure below. That creates lift, causing the paper to rise.)*



2. Next have students fold 1-inch flaps along the two shorter edges of the paper. Have them turn the paper over and fold two more 1-inch flaps along those same edges. Finally, have them set the paper on a tabletop so that there is a gap between the paper and the table. Ask them to blow forcefully through the gap. What happens? *(Faster-moving air below the paper creates an area of low pressure. The high pressure above pushes downward, creating downforce and causing the paper to sag.)*



BUILD

What is the relationship between air speed and air pressure?

1. Pass out *Assembly Sheet B*, *Activity Sheet 2: Downforce*, and experiment materials. Have pit crews complete the experiment. If students have trouble, make sure the straws are not taped at an angle and the top of the spool is completely covered.
2. After groups complete the Conclusions questions, challenge them to think of other objects that rely on lift or downforce to operate. *(Answer Key: Experiment: fast/low; slow/high; low/fast; high/slow; low/high/lift. Race car: slow/high; fast/low; high/slow; low/fast; high/low/downforce.)*

EXTENSION: PIT CREW CHALLENGE

TEAM UP

How do race car modifications influence downforce on the vehicle?

1. Pass out copies of *Resource Sheet A*. Point out the race car's splitter and skirting. Explain that these adaptations enhance the car's downforce by directing fast-moving air underneath it (splitter) and preventing slow-moving air from slipping underneath its sides (skirting).
2. Pass out card stock, scissors, and the completed cars from Lesson 1. Have pit crews use *Resource Sheet A* to guide them in adding spoilers, splitters, and other features to their cars. After they have adapted their race cars, ask students to write two or three paragraphs explaining:
   - how the speed of airflow creates air pressure, drag, and downforce
   - how a race car's spoiler increases drag and creates downforce
   - how a race car's splitter and skirting help keep the car on the track

   You may choose to share *Resource Sheet C* with students for a visual illustration of where race cars experience air pressure.

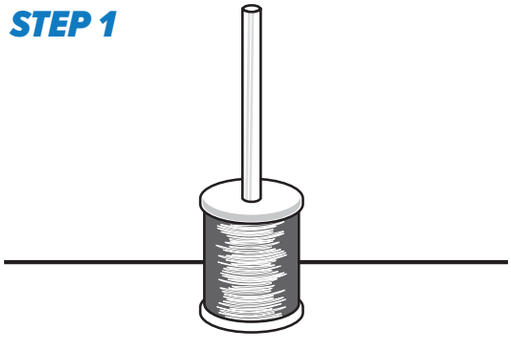
ASSEMBLY SHEET B

PRESSURE-TEST SPOOL

GATHER YOUR MATERIALS

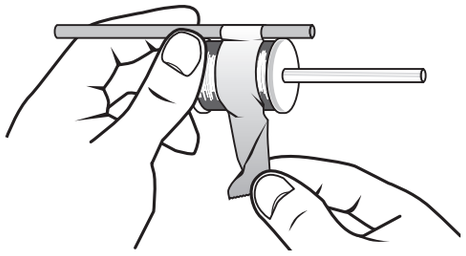
Standard spool of thread, plastic straw, scissors, ruler, index card, tape, hole punch

STEP 1



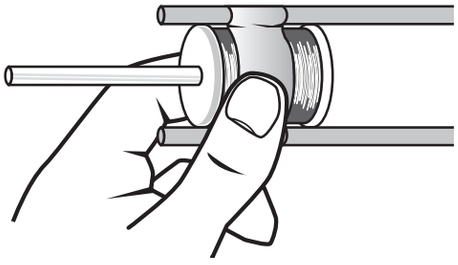
Place the spool on a flat surface and insert the leftover straw from the race car experiments into the center hole. Tape the straw to the top of the spool. Make sure that any openings on the top of the spool are completely covered.

STEP 2



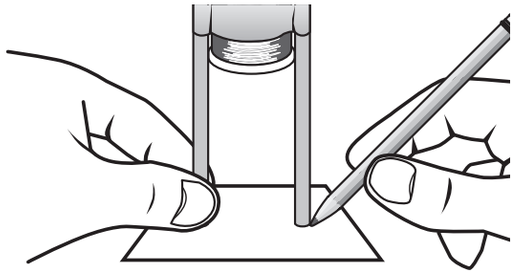
Cut a straw in half. Hold the spool sideways. Align one half of the straw to the side of the spool and tape it in place so that the straw sticks out from the bottom of the spool.

STEP 3

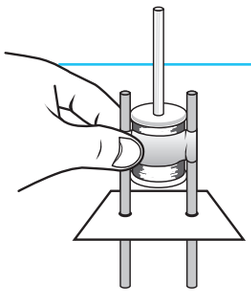


Flip the spool over and tape the second straw in place.

STEP 4



Cut a 2-inch-by-2-inch square from the index card. Stand the spool over the cut card and trace the shape of the straws on the card.



COMPLETE YOUR PRESSURE TESTER

Punch two holes in the card where you have marked them. The holes must be larger than the straws to allow the card to easily slide down the straws when you're not holding it in place. Thread the paper onto the straws. Make the holes larger as needed. **Your pressure-test spool is now complete!**

NAME _____

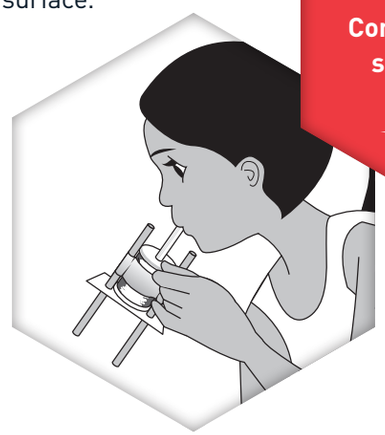
UNDER PRESSURE

How do NASCAR race cars stay on the track?

Race cars are designed to force air to flow faster underneath them than over the top. The low pressure below the car sucks it down toward the track. At the same time, high-pressure air pushes down on the car from above. Try this experiment to demonstrate how air pressure shifts can cause an object to stick to a surface.

GATHER YOUR MATERIALS:

Completed pressure-test spool with index card



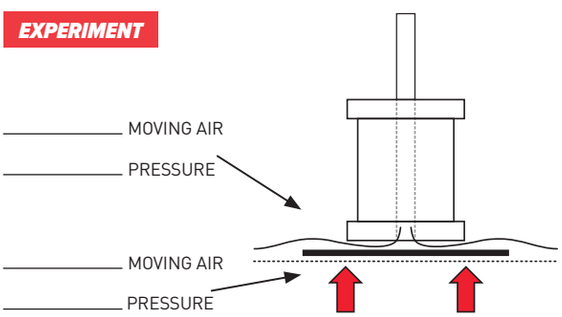
PROCEDURE

1. Thread the index card on the straws and hold it against the bottom of the spool.
2. Blow strongly through the straw and let go of the card. How long can you keep the card suspended?

CONCLUSIONS

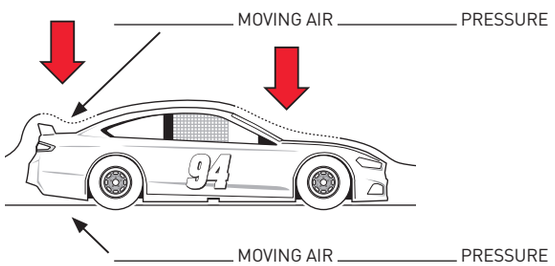
Lift or downforce? Fill in the blanks below to explain how fast- and slow-moving air create low and high air pressure, which lead to lift or downforce on an object.

EXPERIMENT



The _____ air pressure above the card was caused by _____ moving air. The _____ air pressure below the card was caused by _____ moving air. The combination of _____ air pressure above and _____ air pressure below creates _____ .

RACE CAR

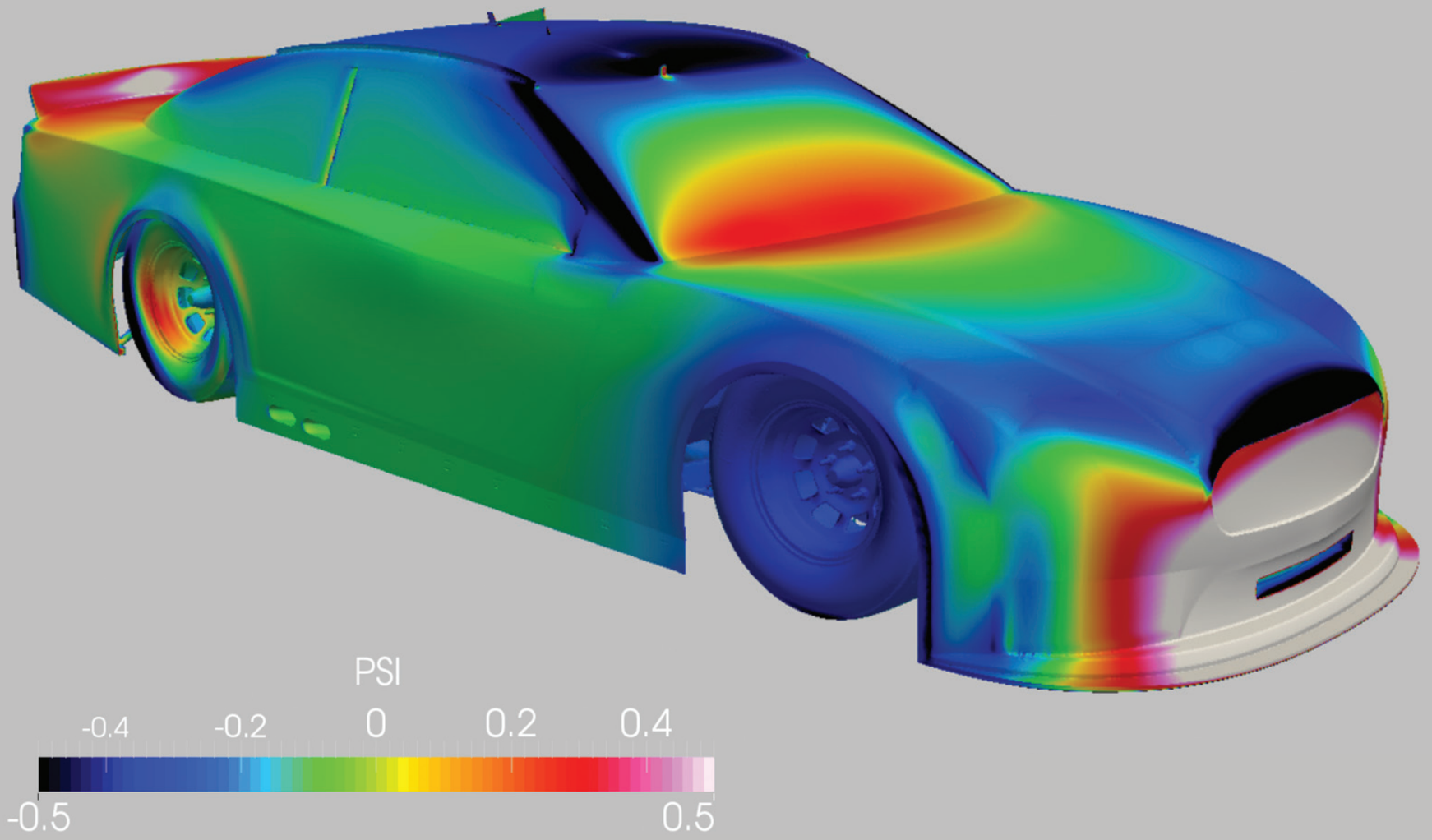


The _____ air pressure pushing downward above the front and back of the car is caused by _____ moving air. The _____ air pressure below the car is caused by _____ moving air. The combination of _____ air pressure above and _____ air pressure below creates _____ .

RESOURCE SHEET C

A FOCUS ON AIR PRESSURE

Take a look at the image below to discover exactly where a NASCAR race car experiences pressure. The areas of high PSI are the areas of the race car that receive the most downforce. As the higher amounts of pounds per square inch push down on the race car, it experiences more traction and sticks to the track.



LESSON PLAN 3: AERO BALANCE

BALANCE IN ACTION

TIME REQUIRED 45 minutes, additional time may be required to build model cars

MATERIALS Assembled race cars from Lesson 1

ACTIVITY AND RESOURCE SHEETS Assembly Sheet A and Car Template (as needed), Resource Sheet B, Activity Sheet 3: Aero Balance. **Download additional sheets as needed at scholastic.com/nascarspeed.**

THINK

What is aerodynamic balance?

1. Ask a volunteer to define **downforce**. (Downforce is the downward force on a vehicle caused by air pressure differences.) Review *Resource Sheet B* and the areas of high pressure air around a race car. Ask students to identify areas of high pressure (the front and back of the car, as well as at the crease of the windshield).

2. Introduce **aerodynamic balance**, or **aero balance**—the pattern of downforce on a vehicle. Explain that the downforce—or high pressure pushing down on a car—can have different amounts of pressure. Ask volunteers to suggest ways that imbalance, or more downforce in one area, might affect a car. (Answers may include making the vehicle flip, spin, or tilt.)

MOVE

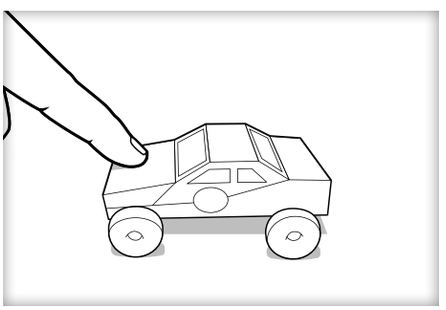
Why is aerodynamic balance important on the racetrack?

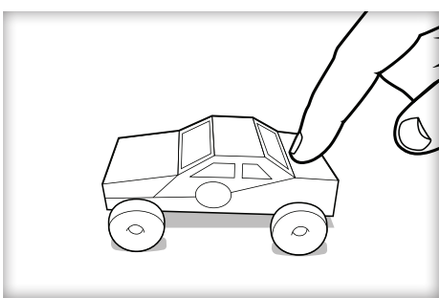
1. Explain that NASCAR engineers work hard to manage the aerodynamic balance between the front and back of the vehicle. When the downforce at the front of the car is well balanced with the downforce at the back, then the car is easier and safer to drive.

2. Introduce the concept of **grip**. Grip between a race car's tires and the road helps the car to steer. Point out that race cars come in contact with the track at four different points (each tire). The downforce on race cars creates pressure on the tires, which in turn creates grip. One of the main goals of aerodynamic balance is to make sure there is balanced grip across the car's four tires.

3. Explain that aerodynamic balance helps keep cars level on the track as they are racing. Place a model car on a tabletop where all the students can see it. Explain that you will now demonstrate how grip impacts a race car's steering. Apply gentle pressure to the car's hood. Make sure students note how the car's back wheels lose contact when pressure is applied to the front of the car. Then apply pressure to the back of the car. Make sure students note that now the car's front wheels lose contact due to the pressure applied to the back of the car.

4. Introduce the terms **oversteer** and **understeer**. Greater downforce at the front of the car is called oversteer, which causes the car's rear tires to lose grip while the front tires retain traction. On the other hand, understeer or "push" occurs when greater downforce at the back of the car causes the rear tires to retain grip while the front tires lose traction.





BUILD

What are the effects of poor aerodynamic balance?

1. Tell students they will use their model cars to observe aerodynamic balance firsthand.

2. Distribute *Activity Sheet 3: Aero Balance*, and review instructions with students. If students need help understanding how to manipulate the car, you may repeat parts of the demonstration from Step 3 in the MOVE section above.

EXTENSION: PIT CREW CHALLENGE

TEAM UP

What happens to race cars when they understeer and oversteer?

1. Tell students to conduct online research (using videos and text) to learn more about oversteer and understeer.

2. Have students form small groups and tell them that they'll be hand-printing small books. Ask student groups to fold standard 8.5" x 11" sheets of paper into halves twice to yield four evenly shaped squares (eight pages total). Instruct them to cut the paper into squares and staple their books along the edge for "binding." Offer the class additional sheets of paper as needed.

3. Ask students to work together to craft their own informational books that demonstrate and explain understeer and oversteer. In text and illustrations, have students explain what oversteer and understeer are—what is the result of each, why it happens, and what it looks like. Allow groups to determine exactly how their books will look and how much text and how many illustrations they'll use.

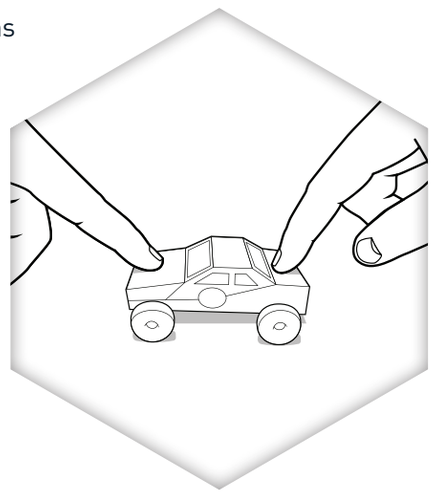
NEW ONLINE SIMULATION

Visit **scholastic.com/nascarspeed** for an online interactive simulation that will allow students to apply aerodynamics principles to design, then drive their own race cars!

NAME _____

OBSERVING AERO BALANCE

How does aero balance affect a car? Greater or lesser **downforce** in one part of a race car can make it aerodynamically imbalanced. In this activity, the pressure of your fingers will stand in for aerodynamic downforce. Try the experiment with your model car to gather observations about how differences in downforce affect steering.



PROCEDURE

1. Place the index finger of one hand on the front hood of the car. Place the index finger of your other hand on the rear of the car, near the spoiler.
2. Adjust the amount of force you apply downward and attempt to roll the car forward and steer it left and right.
3. Record detailed observations about the ease or difficulty of steering in the chart below.

DATA

Large amount of force	Small amount of force: Front	Small amount of force: Back
Front		
Back		

CONCLUSIONS

Answer these questions on a separate sheet of paper.

1. Which combination of forces made the car easiest to steer? Which combinations made it difficult to steer the car?
2. Based on your observations, why is aero balance important to race car performance and safety?
3. Based on your observations, what effect did downward force have on **grip**?