NASCAR KIDS

STEM AT THE TRACK

A Guide for Science Lessons & Activities at the Racetrack

Grades K–12

In partnership with

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National Science Teaching Association

Dear Track Personnel,

While NASCAR's race cars may run on fuel, we know it's the science behind the race that makes it all possible—from drag, downforce, and drafting to force, friction, and energy. As part of our collaboration between National Association for Stock Car Auto Racing, LLC (NASCAR) and the National Science Teaching Association (NSTA) to develop new science curriculum for educators nationwide, we created this STEM at the Track Guide as a way to bring the excellence and innovation in science teaching and learning NSTA is known for right to the track, so students can see, smell, hear, and feel science in action.

Did you ever get asked how exactly NASCAR drivers communicate from their car? Or why does a race car look the way it does? Or what exactly does a Race Director do? The following activities, grouped by age-appropriate content for elementary, middle, and high school levels, will take a deeper dive into these types of questions with a fun and interactive approach.

Take the time to allow students to explore, ask questions, and experience the many examples of STEM in action throughout the track using the following lessons and activities.

We thank you for your interest in sharing a love of STEM with students at your track. We hope you find these materials fun and inspiring—you never know when you'll be sharing these with the next Team Engineer, Race Director, or Technical Inspector!

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"We are elated to be partnering with NSTA, a passionate community of science educators and professionals devoted to teaching and offering science resources to kids in our country. This collaboration will allow NASCAR to make an impact in science education while introducing new generations to the sport."

Peter Jung
NASCAR's Chief Marketing Officer

How Do NASCAR Officials Communicate Using Flags?

Grade Level	Topic	NGSS
K-5	Communication	PS4.C

Phenomenon

NASCAR officials use flags to communicate over a distance.

Materials

- Kid Flag Man Video
- Picture of NASCAR flags without explanations
- Have You Wondered NASCAR Flag Video

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.

SCIENCE AND ENGINEERING PRACTICE(S)	**Asking Questions and Defining Problems** Ask questions based on observations to find more information about the designed world. **Planning and Carrying Out Investigations** Make observations (firsthand or from media) of a solution to determine if it solves a problem or meets a goal. **Planning and Carrying Out Investigations** Make predictions based on prior experiences.
DISCIPLINARY CORE IDEAS Targeted Science Ideas and Engineering Ideas (when applicable)	**PS4.C Information Technologies and Instrumentation** People also use a variety of devices to communicate (send and receive information) over long distances.
CROSSCUTTING CONCEPTS	**Patterns** Patterns in the natural and human-designed world can be observed, used to describe phenomena, and used as evidence.

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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.

T What is the teacher doing to support students' sensemaking?	S What are students doing to make sense of the phenomenon? (Includes teacher look-fors)
Before Visiting the Track / Before Race Day	
Tell students that you will be taking a trip to a NASCAR race track. Explain to students that before you take your trip, you want to learn a little more about NASCAR and races.	
Tell students you are going to show them a video of Bowman Gray Stadium and a young race fan who is a little older than they are. Tell students that you want them to collect their notices and wonderings. Have students create a t-chart with I Noticed in one column and I'm Wondering in the second column. Teachers should create their own chart for the class on a whiteboard, chart paper, or interactive screen.	Students set up a t-chart by labeling one column I Noticed and the other column I'm Wondering.
Play the video for the students. Afterward, give students time to record their observations.	Students watch the video. As they watch, students make observations using their eyes and ears. They record observations and questions on their Notice and Wonder charts.

T	S

Allow students a few minutes to discuss their notices and wonderings with partners. Then have partner groups share with the whole class. Record student noticings first.
• If student struggle to articulate their "noticings," consider prompts such as these:
  ◦ What did you notice about the flags?
  ◦ Did the boy wave the same flag the whole time?
  ◦ Did he wave different flags?
  ◦ What patterns did you see in the video?
Next, have students share their "wonderings" and document these in another column.
• If students struggle to articulate their "wonderings," consider prompts such as these:
  ◦ What questions can we ask about the flags? (*Why do the flags have different colors?*)
  ◦ What questions do we need to ask to figure out why the boy was waving the flags? (*Why do they wave flags at NASCAR races? Why did he wave a different colored flag at different times? Why did he wave two flags at once?*)
	Students respond by sharing ideas, first with a partner, then with the class.
	Students share their observations and questions on their Notice and Wonder charts.

After all student groups have shared both a notice and a wonder, acknowledge that several of them noticed that the boy was waving flags at the drivers and that those flags had different colors. If no one mentioned that the flags had different colors, model your thinking to the students by asking this: "Was there any other things about the flags that we noticed?" This should lead students to notice the flags had different colors.	
Ask students to think about why NASCAR might use different colored flags. Give students a few minutes in the "Alone Zone" to formulate their ideas. Then tell them that you'd like them to predict why they think there were flags with different colors.	Students use the class Notice and Wonder chart and their personal observations to make predictions.

T	S
Allow students time to share their predictions with the class, and record their predictions in a shared space. Highlight student predictions that include the flags being used as a way to communicate with drivers. To help students focus on the relationship between their observations and their predictions, consider the following suggested prompts: • What data did you use to make your prediction? • How did the patterns you observed help support your thinking? • Did the patterns you observed support your prediction? • Did the patterns in our observations support our conclusion that the flags are used for communication? Why or why not? Tell students that when they visit the race track, you want them to ask questions about these flags to find out more information.	
Divide students into groups and have them think together to develop new questions about the flags or revise previously developed questions. Have students revisit the "wonderings" list and prompt them to read through the list. Tell students to focus on questions about the flags and/or communication. Student questions could include these: • Why are different colored flags waved during a race? • How does the boy know which color flag to wave at different times? • Why are flags used during a race? • What do the different colored flags mean?	Students generate questions about the phenomena they observed that will help them acquire more information.

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.

Students ask questions about the phenomena they observed that will help them acquire more information. They record this information to take back to the classroom.

T S

Race Day

Tell students that they will be watching a NASCAR race that will be televised. Tell them that there will be commentators who will be giving them information about the race as they watch it. Tell students that they are to gather data about the different colored flags and their purpose during a race. Encourage students to record data such as the following:

- Where is the flag being used?
- Who is waving the flag? If students don't know the position of the specific person, have them describe the person's role using their own words.
- Where is the person waving the flag?

Remind students they can use pictures, symbols, and words to document their observational (qualitative) data.

Students will watch the race and gather data they can use as evidence using observations (their eyes and their ears). Students should be looking for patterns of when the flags are used in the race.

Explain that all the data they collect at the track will be analyzed when they return to class. Explain that they will use some of the data as evidence to figure out how the different colored flags are used.

At the Race Track

Have students work collaboratively to collect information about the different types of flags used by NASCAR and their purpose.

Consider providing students with the questions that they generated before the visit to guide their investigations.

If students have the opportunity to meet with someone from the track, encourage them to ask their questions to gather some data.

During the Race

Allow students to watch the race. Remind them that they are looking for evidence that the flags are used as a means of communication with the drivers.

T S

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 the Track Visit / After Race Day

After returning from the visit, have students return to the class "notice and wonder" chart.

Remind students, "We were wondering why NASCAR had the different colored flags and what they were used for in a race."

Divide students into groups to share the data they collected at the track. Tell them to compare their data to figure out what pieces could be used as evidence. Next, reorient students to their "wonderings," then facilitate a whole-class discussion in which groups share their evidence. Ask students what questions can they answer now that they have more information. Also, have students revisit their predictions and prompt them to think about how their evidence supported their ideas that the flags were used to communicate with the drivers.

- An alternate option would be to have individual students or groups of students write their explanations.

If students were unable to gather evidence for all the flags' colors, show the the Have You Wondered video.

Students work in groups to compare their data to see what they can use as evidence to answer their questions.

Students revisit their predictions to see if their data supports or refutes their predictions.

Prompt students to think about why it is important to be able to communicate this way with NASCAR drivers. Students' ideas will vary but focus on the ideas that using the flags lets drivers know what is happening on the track right away.

Ask the students to think of other examples of how devices are used to communicate over a distance.

Students are prompted to consider why using flags to communicate with drivers would be important.

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

PS4-3. Generate and compare multiple solutions that use patterns to transfer information.

[Clarification Statement: Examples of solutions could include drums sending coded information through sound waves, using a grid of 1's and 0's representing black and white to send information about a picture, and using Morse code to send text.]

How Have Science Discoveries Helped Shape Race Cars?

Grade Level	Topic
MS	Science and Technology

Phenomenon

Modern-day NASCAR Cup Series cars look very different from those of 20 and 40 years ago.

Materials

- NASCAR Cup Series Cars Over Time presentation
- STEM Teaching Tools Constructive Conversations Resource Cards
- New York Times article
- The Evolution of NASCAR Cup Series Cars website

Material Management Tips

- Make copies of the Constructive Conversations Resource Cards for each group.
- Consider sharing the NASCAR presentation.
- Provide copies of the New York Times article for each student.

SCIENCE AND ENGINEERING PRACTICE(S)	**Asking Questions and Defining Problems** Ask questions that arise from careful observation of phenomena to clarify and/or seek additional information. **Engaging in Argument from Evidence** Respectfully provide and receive critiques about one's explanations by citing relevant evidence and posing and responding to questions that elicit pertinent elaboration and detail.
CROSSCUTTING CONCEPTS	**Cause and Effect** Cause-and-effect relationships may be used to predict phenomena in natural or designed systems.

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Safety

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EXPERIENCE PHENOMENON

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T What is the teacher doing to support students' sensemaking?	S What are students doing to make sense of the phenomenon? (Includes teacher look-fors)
Tell the students that you are going to show them a slideshow of 20 different cars. You want them to carefully observe the presentation and record their observations. The slides can also be printed and cut out to allow students to compare them individually or in small groups.	
Show students the NASCAR Cup Series Cars Over Time presentation. Ask students to look for similarities and differences among the cars. Allow students a few minutes to individually make general observations. For example, differences could include that the car's shape has changed, the tires seem bigger, and the cars are closer to the ground. Similarities could include that the cars all have a windshield, are painted with team colors, and have windows. The goal here is not to compare specific cars to one another but to notice change overall.	Students make observations to identify similarities and differences among the cars. Students share their observations.

T	S
Next, divide students into groups, and have them share what they noticed. As groups discuss what they see, have them keep track of the observations. Have small groups share their observations with the whole class. Tell the groups they will each share one observation at a time, and they will go around the room several times if needed to make sure all their observations are shared. As groups share, record their observations on the board, and ask students to give a thumbs-up if they had the same/similar observation, and add a checkmark for each group.	Students think individually, then respond by sharing ideas with the class.
After each group has shared a similarity or difference, say, "Many of you noticed that the cars become more modern over time. What ideas do you have about why the cars are so different at the beginning of the presentation from what they are by the end of the presentation?" Answers here will vary but focus on ideas about advancements in science and technology. These ideas could include the following: • The newer cars are designed to go faster. • The cars now are safer. • They are made from different materials.	Students share their ideas about why cars might have changed over the years.
Ask students to think about how NASCAR teams knew how to make all these changes. Prompt students to brainstorm ideas in their small groups around this question: "How did the NASCAR teams figure out when to modify their cars?"	Students brainstorm ideas about how NASCAR teams know how to modify their cars. Students share their ideas with the whole class.
When groups are finished, have them share their ideas. Student ideas here will vary, but many will share that the cars changed because of new inventions, or the teams figured out something that worked better. Tell students that a key element in understanding the nature of science is the idea that technology influences the progress of science and science influences advances in technology.	

T S

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, tell students that you have an example of a scientific discovery by a race car driver that led to changes in the technology of a NASCAR car. Have students read the first five paragraphs of this New York Times article from 2008. After allowing time for students to finish reading, ask them to discuss these questions:

- What scientific discovery was made?
- What evidence is there for that discovery?
- How did the technology associated with NASCAR change?

Students read the *New York Times* article *"NASCAR's Screech and Slam? It's All Aerodynamics"* to gather evidence on how scientific discoveries can lead to changes in the technology and techniques used in NASCAR races. Students discuss the questions to get them thinking about how technology drives change in NASCAR.

Ask students to review the Evolution of NASCAR Cup Series Cars (these are the same cars from the original presentation). Ask students to choose a car from Generations 4, 5, and 6 and make a claim about the scientific and technological advancements of that car compared to its predecessors in Generations 1, 2, and 3. Tell students that they will need to identify the evidence that supports their claim and show their reasoning for how scientific understandings and/or design solutions support the evidence they have identified. If students struggle to connect scientific understandings with their evidence, consider the following prompts:

- How does your understanding of forces support your evidence?
- How does your understanding of changes in motion energy support your evidence?
- How does your understanding of changes in state as a result of a change in temperature or pressure support your evidence?
- How does your understanding of energy support your evidence?

Students revisit the pictures from the beginning of class to compare different generations of NASCAR race cars. Students develop claims that are supported by evidence and reasoning.

T	S
Now that students have some idea about why different changes were made, have them generate a list of questions that can be investigated while at the track. Questions could include items they can ask NASCAR personnel or questions they could answer by making careful observations. Have students share their questions with the class. As they share, document their questions on the board or digitally. You could also make printed copies of the questions that students could take with them to the track.	Students generate a list of questions to which they still want to figure out answers.
If student questions include figuring out more about the aerodynamic forces that act on cars as they are moving around the track, encourage students to take some pictures or short video segments of these forces in action so they can use them as data in their explanation.	

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 their trip to the track, have students meet in their groups to share the data they gathered at the track. As students share their data, prompt them to revisit their questions to determine what evidence they could extract from their data to answer their investigative questions.	Students share their ideas with their peers.
Now that students have some idea about the various questions they can answer, have each student in the group make a claim about a question. Each student should choose a different question to focus on. Also, explain that they may use data collected from other group members to support their claim but must give that student credit. Explain that in science, there is a sharing of ideas, so it is acceptable to use others' research as long as credit is given. If students are not familiar with citing sources, provide an example of what that might look like in this setting.	Students respectfully respond to one another's ideas by using the sentence stems provided.

T	S
Next, provide students with the **STEM Teaching Tools Constructive Conversation Cards.** * Students will need the Clarify and Fortify/Support cards. Tell students that each member of the group will present their claims and evidence, while other members will use the prompts on the Clarify and Fortify/Support cards. Each group member needs to take a turn presenting claims and evidence.	
After every member of the group shares, have students write an explanation for why the cars have changed over the years.	Students create explanations for why NASCAR cars have evolved over time using evidence. Students use conversation prompts to help their group members clarify and revise their claims after they have shared their ideas with the group.

What Career Opportunities Are There in NASCAR?

Grade Level	Topic
HS	Careers

Materials

- Student-generated interview questions
- Daytona 500 Introduction video
  - Only show the first 39 seconds of the video.
- Daytona 500 Infield picture

Material Management Tips

- Make copies for students prior to arriving at the track.
- Convert the document to an electronic format so students can use their devices to collect information.

SCIENCE AND ENGINEERING PRACTICE(S)

Asking Questions and Defining Solutions

Ask questions that can be investigated within the scope of available resources.

Obtaining, Evaluating, and Communicating Information

Gather and evaluate scientific and/or technical information from multiple authoritative sources.

Safety

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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.

T What is the teacher doing to support students' sensemaking?	S What are students doing to make sense of the phenomenon? (Includes teacher look-fors)
What are the different types of careers one could have with NASCAR?	
Before Visiting the Race Track Ask students if they've ever watched or been to a NASCAR race or any other race. Ask students if they've ever wondered what kind of jobs are necessary for a track to host a race.	
Next, play the Daytona 500 Introduction video (from the start to 0:39). As they watch, ask students to look for evidence of the different types of jobs they observe.	Students watch the video to gather evidence about the different types of jobs associated with NASCAR.
After watching the video, allow students time to work with a peer to share what they have observed and create a combined list. Allow students to share their observations with the whole class.	Students respond by sharing ideas, first with a partner, then with the class.
Next, ask students to predict what types of jobs they might not have seen on the video but would be required to have such a large event. Also, have them include why they think those jobs might be a vital part of the event. Provide students with a few minutes to think individually, then allow them to share their thoughts with a partner. Have pairs of students share their predictions. If students struggle, consider prompts such as these: • Talladega Superspeedway has a capacity of 80,000 spectators in the grandstands and 175,000 total. What jobs would be needed to organize this many people? How would this keep them safe? • Several NASCAR tracks allow camping in the infield before and during races. Some of these campsites include water and electrical hookups. What jobs would be needed to prepare these spaces for visitors? How would they be maintained?	Students use their individual and group observations to make predictions and provide reasoning about why these jobs might be necessary.

T	S
• Millions of people watch the races each week. What types of jobs are needed to produce a video similar to the one we just watched? • Look at the picture of the infield at the Daytona 500 International Speedway. What jobs would be needed to keep the track looking like it does in this picture?	
Point out that several students have identified many different types of careers that might be found at a race track. Ask students how they might be able to find out more about these different types of careers to determine if this would be something they would wish to pursue after high school. Allow students to share their suggestions. Point out to students that several students stated that interviewing or "talking to" individuals who work at race tracks would be a good way to find out more about these types of jobs. Next, tell students that to use their time at the track wisely, they will need to identify key pieces of information about the careers from those individuals that they will interview.	
Ask students to brainstorm what they think would be helpful information to have when deciding if this is a career field they might want to pursue. Have students work in pairs to develop as many questions as they can to help them determine if a career would be of interest. Then have students work in groups of four to discuss and evaluate their questions to narrow their questions down to 5 for the group. Have all groups collaborate to share and gather feedback to identify key questions for their interviews. To guide students in developing their questions, consider prompts such as these: • Could this question be answered through an interview? If not, what other resources could be used? • What additional questions might be necessary to clarify or elaborate on an explanation you're given?	Students generate questions about the jobs they have identified and observed that will allow them to discover more information. Students work in groups to share and evaluate their questions to narrow their questions down to the five that they think will provide them with the most information.

T S

If students seem to struggle with education requirements and salary, consider prompts such as these:

- How might this job change in 5 years? 10 years? What is the overall outlook for this type of position?
- What is the time requirement for this type of position? What might a typical schedule look like?
- What is the work environment for this position? What are some safety concerns?

Encourage students to include questions about how these careers/jobs have changed over time. Consider questions about jobs that exist today and those that might not be available now but could be in the future. Have students revise their lists to incorporate questions that would elicit this type of information during their interviews.

Tell students that there are several job titles that you have received from NASCAR for them to investigate. Tell students that they will work in teams to conduct investigations at the track. Remind them that they will need to be sure they collect the answers to the key questions identified by the class, but they are free to ask additional questions if time allows.

NASCAR Job Titles

- Team Engineer
- Series Director
- Event Management
- Technical Inspector
- Chief Racing Officer
- Race Director
- Racing Development
- Event Experience and Operations
- Track Marketing
- Racing Communications

T S

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.

At the Race Track

Allow students the opportunity to interview different individuals at the track. Remind them that sometimes a person can tell them about a job that they might not do but know about, in case they can't find someone who has that job title during their visit.

Students ask questions about the jobs they have observed and identified to find out more information about that career. Students will record this information to take back to the classroom.

Encourage students to make observations and gather data about how jobs around the track might have changed over time and ideas about how these jobs might look in the future based on the development of new technology.

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 the Track Visit

Now that students have visited the track and have a better understanding of the types of jobs and careers associated with NASCAR have them revisit their list of jobs they identified prior to the visit.

For each job they observed or predicted, have them match that with the job title that they learned more about as a result of their interviews. Allow students to work in teams to complete this activity.

Finally, have students reflect on the job titles presented and those they discovered during their visit. Have students identify which of these jobs belong to a STEM field. Have students identify the science field(s) most closely associated with that job and the types of technology, engineering, and math that are required for each.

Students think individually, then respond by sharing ideas, first with a partner, then with the class.

Elevate STEM Learning Through the Sport of Racing

www.nsta.org/nascar-kids

Free Lesson Plans

Grades K-2

- How Do Things Make Sound?
- What Materials Are Used to Make NASCAR Race Car Parts?
- Why Is Metal Used to Build Race Cars?
- Why Is Plastic Used to Build Race Cars?
- Why Is Rubber Used to Build Race Cars?

Grades 3-5

- Why Do NASCAR Drivers Need to React Fast? *Part 1: Sight*
- Why Do NASCAR Drivers Need to React Fast? *Part 2: Sound*
- How does the air in tires support a 3300-pound race car?
- Why is rubber used to build race cars?

Middle School

- Why Are NASCAR Crashes So Dangerous?
- How Can Race Car Bumpers Store Energy?
- How Can Air Make a Race Car Faster?
- How Do NASCAR Race Car Tires Take the Heat? (Part 1: Physical Changes)
- How Do Roof Flaps Make a Race Car Safer?
- How Does Air Temperature Affect Race Car Tires?
- How Does Air Affect the Motion of a NASCAR Race Car?
- How Does Being Close to the Ground Help a NASCAR Race Car?
- How Do NASCAR Race Cars Come to a Stop After Moving at Speeds Over 200 mph?
- How Do NASCAR Race Car Tires Take the Heat? (Part 2: Thermal Energy)

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