Part 1: Physical Changes

How Do NASCAR Race Car Tires Take the Heat?

Phenomenon

The tires being removed from a NASCAR race car during a pit stop are much warmer than the tires being put on the car.

Materials

- Fox thermal cam video of pit stop with tire change [clip A]
- Thermal Camera Images A-E
- Pink wedge eraser or other rubber eraser
- Surfaces with different textures that are suitable for rubbing the eraser
- [Optional] Thermal imaging camera or infrared surface thermometer
- Friction simulation links—simulation 1 – A microscopic model of friction and simulation 2: Friction
- Markers and paper, chart paper, or whiteboards (for students’ models)

Material Management Tips

- Have all video clips and images loaded and ready to present to students. It is important to follow instructions for muted sound and starting/stopping videos at specific times. This will avoid giving away explanations before the students have a chance to develop their own.
- It is possible to get the erasers hot enough to cause burns on the skin, so monitor students to prevent this from happening.

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.
How Do NASCAR Race Car Tires Take the Heat? (Part 1: Physical Changes)

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SCIENCE AND ENGINEERING PRACTICE(S)

Planning and Carrying Out Investigations
Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon, or test a design solution. (3–5 Grade band)

Developing and Using Models
Develop a model to describe unobservable mechanisms.

DISCIPLINARY CORE IDEAS

Targeted Science Ideas and Engineering Ideas (when applicable)

When the motion energy of an object changes, there is inevitably some other change in energy at the same time.

When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object.

CROSSCUTTING CONCEPTS

Patterns
- Macroscopic patterns are related to the nature of microscopic and atomic-level structure.
- Patterns can be used to identify cause-and-effect relationships.

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.

1. Introduce the Phenomenon

Say to students, “We’re going to watch a race car coming in for a pit stop, but this video was recorded with a special camera.”

Have students set up a Notice and Wonder t-chart on a sheet of paper. Tell them to write down their observations and questions as they watch the video clip.

Students set up a t-chart by labeling one column “Notice” and the other column “Wonder.”
Show students **video clip A** with the volume muted. Students watch video clip A. They might turn and share noticings and/or stories while the clip plays. (Allow this behavior.) As they watch, students make observations using their eyes and ears. They record observations and questions on their Notice and Wonder charts.

Ask them, “What did you notice in the video? What are you wondering?” Have students share with a partner, then with the class. You might record these sharings on a public chart and update it throughout the lesson.

Say to students, “One thing we noticed is that the tires coming off the car looked orange, and the tires going on the car looked blue. And we’re wondering what those colors mean. Let’s look at an image that will give us some more information.”

Show students image A. Have students update their Notice and Wonder charts, then share new observations and questions with the class.

Say to students, “The tires are warm before they go on the car and very hot after they have been on the car during racing. We’re wondering why this happens and how it might affect the race 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.

#### 2. Carry out an investigation

Say to students, “We know tires are made of rubber and that they are constantly moving across the paved track during a race. Let’s investigate how that might affect the tires.”
Have students work in pairs or small groups. Share this procedure with students.

1. Choose a surface.
2. Lay one of the wide faces of your eraser flat on the surface and drag it back and forth for about 30 seconds.
3. Note any changes to the surface of the eraser and touch the surface of the eraser and the surface you are dragging it across with your fingertips.
4. Repeat this several times and notice any changes.
5. Update your Notice and Wonder chart with your observations and any new questions.
6. Choose a new surface that has a different texture (rougher or smoother) than the first one. Repeat steps 2–5 with the opposite face of the eraser.

Students follow the procedure to carry out the investigation. They record observations and questions on their Notice and Wonder charts.

Have students share new observations and questions, first with a partner, then with the class.

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

Say to students, “The eraser gets warmer as we rub it across a surface. Let’s look at some images of a similar investigation.”

If you have a thermal imaging camera or infrared surface thermometer, you and your students can collect data during their hands-on investigations.

Share images B–E with your students. Have students update their Notice and Wonder charts as they view the images.

- Image B. Visible light image of eraser and cardboard before rubbing
- Image C. Thermal camera image of eraser and cardboard before rubbing. This image was taken with a thermal camera similar to the “Fox Heat Seeker” camera, although the scale is different. The target on the image indicates the temperature of the surface at that location.
- Image D. Thermal camera image of eraser and cardboard after rubbing
- Image E. Visible light image of eraser and cardboard after rubbing

Students view the images and record observations and questions on their Notice and Wonder charts.
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.

3. Developing and Using Models

Say to students, “We know that friction produces thermal energy, but can we explain why that happens? We’re going to use two simulations to help us figure this out.”

Students view short race clip.

Share the simulation links with students, and have students work in pairs or small groups. Share the following directions with students.

1. Explore both simulations.
2. As you explore, think about the following questions.
   - What causes friction?
   - What causes greater friction on one surface than another?
   - How does friction produce thermal energy?
3. Use the ideas you gained from the simulations to develop a model that you can use to explain the different effects you observed on the two different surfaces you used in your investigation. As student groups work on their models, ask the following questions:
   - How could you use ideas about forces to describe what causes friction? (If students have a difficult time using ideas about forces, ask them to use “push” and/or “pull” to describe what is causing friction, then ask them to substitute “force” for push and pull.) How might you represent forces on your model using words, pictures, and/or symbols?

Students follow the procedure to explore the simulations, then develop small-group models.

Students share by using their models to explain why the eraser was affected differently by the two different surfaces.
How could you use ideas about energy to describe how the motion (kinetic) energy of the object(s) is transformed to thermal energy? How might you represent energy on your model using words, pictures, and/or symbols?

4. Include zoom-in bubbles in your model to show what those two surfaces would look like if you could zoom in like the simulations do.

Have each group share their model. Sequence these presentations so the models generally move from simplest to most complex. Encourage students to critique and build on one another’s ideas by providing them sentence stems such as these:

- I agree/disagree because…
- I would like to add on to [student]’s idea…
- This makes me think about…

Students respectfully respond to one another’s ideas by using the sentence stems provided.

Students respond by sharing ideas for the must-have list. The must-have list should include the following key features.

- Shows particles that make up the two materials;
- Shows “peaks and valleys” in the surfaces;
- The rougher surface has higher and/or more irregular “peaks and valleys”;
- Indicates vibration of particles as surfaces move across one another;
- Rougher surface leads to greater vibrations, which leads to higher temperature/more thermal energy; and
- May show surface breaking down/particles being displaced or dislodged.

Say to students, “Let’s think back to the tires that were coming off the race car in the video clip. How is our eraser like those tires, and how is it different?” Show video clip A again, if needed.

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

Have students share ideas with a partner, then with the class.

Say to students, “The tires are just one part of a race car that experiences friction. Let’s see how friction can affect another part of a racecar, the engine.” Show video clip B, beginning at 3:58.
Nice day for a race, or is it?

Weather conditions, from a cool damp spring day to a hot sunny afternoon, can play a big role in race conditions and even whether a race can be run on schedule. These weather conditions can directly affect friction or can add to the side effects of friction. What is today’s weather at the track? How do you think it is affecting the race?

On the right track?

The surface of each race track in the NASCAR series is different. How does the surface of the track you are visiting today compare with the surfaces of other tracks in the NASCAR series? Check out the Surface texture of NASCAR tracks [smooth to rough] web page to find out.