nsta Daily Do

FUELED BY: NASCAR KIDS

How Does the Air in Tires Support a 3300-Pound Race Car?

Grade Level	Topic	NGSS
3-5	Properties of Materials	PS1.A · PS2.A

Phenomenon

Tire going flat

Materials

- Video Clip—Kevin Harvick's flat tire

Investigation Materials (One per group)

- One per group
- 1–2 plastic syringes
- 1–2 syringe caps (optional)
- whiteboard or larger sheet of paper for student models and explanations

Material Management Tips

- Keep syringe caps in a smaller plastic bag, as they are small and easily lost.

SCIENCE AND ENGINEERING PRACTICE(S)	**Developing and Using Models** Develop and/or use a model to predict and/or describe phenomena. **Constructing Explanations and Designing Solutions** Construct an explanation that includes qualitative or quantitative relationships that predict and/or describe phenomena.
DISCIPLINARY CORE IDEAS Targeted Science Ideas and Engineering Ideas (when applicable)	**PS1.A—Structure and Properties of Matter** 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. **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	**Scale, Proportion, and Quantity** Phenomena that can be observed at one scale may not be observable at another scale.

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.

nsta National Science Teaching Association

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	S
What is the teacher doing to support students' sensemaking?	**What are students doing to make sense of the phenomenon? (Includes teacher look-fors)**

1. Introduce the Phenomenon

Show students the video clip—Kevin Harvick's flat tire. Have students write about what they think happens when a car gets a flat tire, using pictures and/or words. Prompt students to think beyond "the car got a flat tire." For example,

- What do we really mean when we say a tire is flat?
- How might having a flat tire affect the car?

Students watch a video clip and write about what they think happens when a tire goes flat.

Encourage students to think about other things that could cause a tire to "go flat." This will help surface student background knowledge and experiences.

Have students share their ideas with a shoulder partner for 2 minutes, then have a class discussion to share all of their ideas. Common student ideas include these:

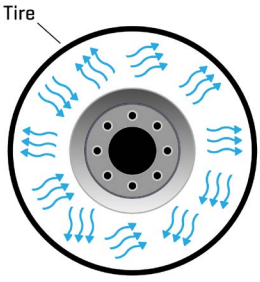
- A flat tire means that the air comes out.
- Things that don't have enough air in them, like tires/balls/balloons, don't seem to work right.
- Things go flat in different ways. Sometimes tires get a hole in them, but sometimes they just get flat, for reasons like when you don't use them for a long time.

Students share their ideas with a partner, then engage in a class discussion.

T	S
Now that students have considered how tires and other objects can "go flat," ask students if they know the different parts of a tire. Have them turn and talk with a shoulder partner for one minute to discuss the prompt "What is a tire? How would you describe its different parts?" Next, ask partners to share their ideas. Once ideas are shared, show and explain the parts of the tire (tread, inflatable liner/tire tube, stem, and rim) using a picture like this one (https://i.redd.it/plf7p8kf7il21.jpg). This will ensure that all students know that the part that holds the air is on the inside and is a big tube. Also, consider having a tire in the classroom to show students.	Students talk with a partner and observe a picture of a tire to figure out its different components.
Now that students know the tire's parts tell them they are going to focus on the tire tube, the part that gets filled with gas (air). Remind students that they have figured out that when things like tires do not have enough air in them, they don't seem to work properly.	

2. Gathering Student Ideas and Questions

Now that students know more about tires, focus on the air. Ask students to think about "air": what it is and what it does. Have students work in small groups to brainstorm ideas they have about air. As students discuss their ideas, walk around the room to listen for any prior understanding about "air." From earlier grades, students may know the following: • Air is a gas. • Air has weight and takes up space. • Air is made of particles too small to be seen (this idea is developed in grade 5 and part of this lesson).	Students brainstorm ideas about air and how air works.
If these ideas don't surface in the discussion, listen for other statements from students that you can capitalize on to get students to understand these science ideas. Listen for students to share experiences with things such as these: • Riding their bikes or other vehicles with inflatable tires; • Playing with an inflatable ball/balloons; or • Ideas about wind.	

T	S
When students have finished brainstorming ideas about air, have them share their thoughts as a whole class. Since students do not all come to us with the same educational experiences and background knowledge, doing this allows all students to hear the ideas of others. When all students have shared, focus on these important scientific ideas. • Air takes up space (it is something even if we cannot see it). • Even though we can't "see" air, we know it is there because it can be contained and measured. • Air is made of particles too small for us to see.	Students share their ideas about air with the whole class.
Now that students know some things about air ask them to work together to draw a model of what they think air might look like inside the car tire. Ask them to picture what an air particle might look like and what it is doing inside the tire to explain how the air keeps the tire inflated. Tell students that models can include both pictures and words. Models must include the tire and air. Remind them that they should include both components and their interactions in the model. Some students may also include the movement of air.  Air moves around in the tire	
When students have finished their models, have students do a gallery walk to look at all the groups' models to notice similarities and differences.	Students observe other groups' models to notice similarities and differences.

T	S
Say to students, "As I looked at your models, I noticed many of you had air in your tire, and some of you had arrows to indicate that the air was moving around. Is that right?" Have a student explain their model and use probing questions to get them to think about why they drew things the way they did. Probing questions could include these: • Tell me more about what you mean by "air moves." • Do we agree or disagree that air moves? • If air doesn't "fill up" the whole tire, how does the tire retain its shape?	Students discuss as a class the ideas that surfaced when developing their models and observing other groups' models.

The idea of "empty space" or the tire not being "completely full of air" is often a difficult concept for students to understand and explain. Allow some discussion about this idea, then tell students you have an activity for them that will help them figure out what is happening in the tire. Some students may also add air outside the tire in their models. Acknowledge that there is air outside the tire, but for this activity, we are going to focus on the air inside the tire.

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.

3. Investigate Air Pressure

Divide students into groups, give each group a syringe or two, and have students make some observations and record what they notice. For example, • What do they notice when they push the plunger in and pull it out? • What do they notice when they put their finger (or cap) over the opening and try to move the plunger?	Students make and record their observations about what the air is doing when they are using a syringe to investigate it.

T	S
After a few minutes of investigation, tell students they are going to focus on what is happening with the air. Give the student groups a whiteboard or larger sheet of paper to use to develop models to explain what is happening with the air. Ask students to again pretend they can see the individual air particles inside the syringe. Tell students to think about what is happening to the air as they move the plunger of the syringe in different ways. Describe to students the following scenarios: • when the hole is open, and the plunger can move freely; • when the hole is covered, and the plunger gets pushed inward; and • when the hole is covered, and the plunger gets pulled outward.	Students focus on developing a model to explain what is occurring with the air in the syringe during different scenarios.

4. Developing Explanations

After the investigations have a class discussion so students can share their current understanding. Students will notice that when the hole is open, the plunger can move back and forth within the syringe easily. Students may say, "Air gets sucked into the syringe and gets pushed out," for example. Explain that it is called an open system, as air can move between the syringe and the atmosphere. Then explain that when we block the opening of the syringe, we now have a closed system, meaning that air can no longer get into or out of the syringe. This means the amount of air inside the syringe stays the same.	Students discuss and share their ideas to develop and build on their current understanding of air.

Next, have students share their observations about when the hole of the syringe was covered. These observations should include the following:

- We could only push the plunger in so far, but not all of the way.
- When we removed our finger from the plunger, it moved back up on its own.
- When we tried to pull the plunger out, we could only pull it out a little, but not all of the way.

T	S
Prompt students to think more about why this happens. Examples of explanations could be these: • When we push the plunger down, we think the air moves closer together. • When we stop pushing the plunger, the air can move around more, so the plunger goes back up by itself. • We think the air moves around and bumps into the plunger to move it. • We think maybe the plunger won't come out because there is not enough air to fill up the space, but we are not really sure because air just moves around.	
Ask students about the interaction when they push the plunger down when the hole is covered. Say, "Many of you noticed that when you let go of the plunger, it moved back up on its own, is that right?" After students confirm this, ask them to think about why it happens. Have students discuss their ideas with a partner or in small groups, then have students share their ideas. Student ideas will vary; however, many will express the idea that the air that was forced down into the syringe pushes the plunger back out.	Students share ideas with a partner or small group, then with the class, about what is happening when the plunger is pushed in.
Explain that what they feel from the plunger pushing back on their hand or the plunger's movement outward is called air pressure. Air pressure is the force within a container, like a tire, caused by the compression of atmospheric gases (air). Air pressure in the car tire was measured in pounds per square inch. Have students add their ideas and explanations to their tire models.	Students make and share predictions about what might happen if there was too much or too little air in a tire.

5. Making Predictions

Now that students have a better understanding of air pressure ask them to consider the following question.

- What do you think would happen if there is too much/too little air pressure in a tire?

If students are having trouble thinking about what might happen, capitalize on prior experiences with balloons or something similar to help them think through their ideas during a class discussion.

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.

7. Making Connections to Air Pressure

Lastly, say to students, "You have figured out some important things about air pressure, but are there other things about air and air pressure that would be important to know regarding racing?" If students are struggling, use the following questions to help surface ideas about air and how it moves.

- Why would air pressure be an important thing to know about when you are inflating a tire?
- Do you think pressure can change even in a closed system like a tire?
- Besides tires, do NASCAR teams consider air and air pressure in other aspects of racing?

Students think about other things NASCAR teams might have to consider about air and air pressure before the race.

Students ideas and questions could include these:

- Is there a certain amount of air you need to put in tires, so they don't have too much or too little air?
- The wind might affect how the race cars move.
- Sometimes my mom has to put air in her tires, so maybe air moves closer together after you drive on tires for a long time.
- The other cars on the track can move air around.
- I have heard people on television talk about getting clean air, but I am not sure what that means.
- Air can have different temperatures, so I think temperature can affect air.

8. Extension Opportunity

Air is a term used to reference atmospheric gases. Many students may think that air is one gas, usually oxygen. However, air is a combination of gases. Nitrogen is one of the gases found in "air" and is the gas that is used to fill NASCAR car (and other cars) tires.

T

Prompt students to think about how using only one kind of gas could benefit the NASCAR team. Ideas could include these:

- Maybe all the different gases in "air" don't all move the same.
- I think it is easier to work with one kind of gas, so you don't have to mix the different gases together.
- Using one kind of gas could be safer, so they only use one kind.

Have students read the following article to learn more about why NASCAR uses nitrogen gas in the tires.

"Why don't they use normal air in race car tires?"

Note—This article was chosen because it offers a brief explanation and does not reveal too much information about the relationship between air pressure and temperature. This relationship is investigated in another lesson: Why would air temperature matter?

S

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

5-PS-1-1—Develop a model to describe how matter is made of particles too small to be seen.

[Clarification Statement: Examples of evidence could include adding air to expand a basketball, compressing air in a syringe, dissolving sugar in water, and evaluating saltwater.] [Assessment Boundary: Assessment does not include the atomic-scale mechanism of evaporation and condensation or defining the unseen particles.]

MS-PS2-2—Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.

[Clarification Statement: Emphasis is on balanced [Newton's First Law] and unbalanced forces in a system; qualitative comparisons of forces, mass, and changes in motion [Newton's Second Law]; frame of reference; and specification of units.] [Assessment Boundary: Assessment is limited to forces and changes in motion in one dimension in an inertial reference frame and to change in one variable at a time. Assessment does not include the use of trigonometry.]

AT THE RACE TRACK

Is all "air" the same?

While you are at the track, watch for teams who are working on the tires. Also, notice what happens to a race car when a tire goes flat.

You may also observe that NASCAR teams do not use regular "air" in their car tires. To find out what kind of gas is used in NASCAR race cars, read the following article: "Why don't they use normal gas in race car tires?"