Tires

Physical Science | Lesson Guide

4th Grade

Photo Description

This image shows the deep grooves and patterns carved into a vehicle tire's surface. The treads (the raised parts) and grooves (the valleys between them) are designed to help tires grip the road. You can also see the metal wheel rim in the background where the tire is mounted.

Scientific Phenomena

Anchoring Phenomenon: Why do tires have patterns on them, and how do those patterns help cars stay safe on the road?

Scientific Explanation: Tire tread exists because of friction—the force that happens when two surfaces rub together. The grooves in tire tread are engineered to increase the contact area between the tire and the road surface, which increases friction. This greater friction helps tires grip wet, icy, or slippery surfaces, preventing the car from sliding. The pattern also allows water and mud to escape from under the tire, keeping the rubber in direct contact with the road. Without tread, tires would have much less grip, making it harder for drivers to control the vehicle, especially in wet conditions.

Core Science Concepts

1. Friction – A force that occurs when two surfaces rub against each other; it can slow things down or help them grip surfaces. Tire tread increases friction between tires and roads.

2. Material Properties – Rubber tires are made from specific materials chosen because they are flexible, durable, and create good friction with asphalt and concrete.

3. Design and Engineering – The tread pattern is deliberately designed to solve a real-world problem: keeping vehicles safe by maintaining grip on various road conditions.

4. Surface Area – The grooves in tire tread create more surface area for the rubber to contact the road, which strengthens the grip and improves traction.

Pedagogical Tip:

When teaching about tire tread, help students make a personal connection by asking them to think about their own shoes. Do their sneakers or rain boots have special patterns on the bottom? This bridges everyday observation to the scientific principle of friction and grip.

UDL Suggestions:

Provide multiple ways for students to explore this concept: tactile (touching real tire tread samples), visual (examining high-quality photos or videos), and kinesthetic (sliding objects across smooth vs. textured surfaces). Allow students to demonstrate understanding through drawings, verbal explanations, or physical models—not just written responses.

Zoom In / Zoom Out

Zoom In: The Microscopic Level
If you could zoom in VERY close to the rubber material of a tire using a microscope, you would see that rubber is made of millions of tiny molecules all linked together like a chain. When the tire presses against the road, these molecules rub against the tiny bumps and grains on the asphalt. This rubbing creates friction at a level so small we can't see it! The grooves in the tire tread help organize these molecules so they can make better contact with the road's microscopic bumps, creating even more friction.

Zoom Out: The Transportation System
Tire tread is just one small part of a much bigger system that keeps people safe when traveling. When you zoom out and look at the whole picture, you see: roads are designed with specific materials, cars have braking systems and steering wheels, traffic laws exist, and tires must work together with all of these to prevent accidents. Tire tread helps connect the driver's control (steering and braking) to the actual road, making the entire transportation system work safely. Without good tire tread, even well-designed roads and careful drivers can't keep vehicles safe.

Discussion Questions

1. What do you think would happen if a tire had no tread at all—just a smooth, flat surface? (Bloom's: Analyze | DOK: 2)

2. Why might tire tread be especially important on rainy days or icy roads? (Bloom's: Explain | DOK: 2)

3. How is the tread pattern on a tire similar to the tread pattern on the bottom of your shoes? (Bloom's: Compare | DOK: 3)

4. If you were designing a tire for a race car that only drives on dry roads versus a tire for a truck that drives in snow, how might you make them different? (Bloom's: Create | DOK: 3)

Potential Student Misconceptions

Misconception 1: "Tire tread is just decorative—it doesn't really do anything important."
Clarification: Tire tread isn't just for looks! The grooves and patterns serve a critical safety purpose. They increase friction between the tire and road, help water drain away from under the tire, and allow the rubber to grip the road better. Without tread, a car would slide easily, especially on wet or icy roads, making it very dangerous. The pattern is engineered science, not decoration.

Misconception 2: "Smooth tires would work better because they would touch more of the road."
Clarification: This seems logical, but it's actually backwards! While a smooth surface might look like it would have more contact, in reality, grooved tires create better grip. The grooves allow air and water to escape, keeping the rubber pressed firmly against the road. Smooth tires actually lose traction because water or air gets trapped between the tire and road, like a thin cushion that prevents proper contact.

Misconception 3: "All tires have the same tread pattern because all roads are the same."
Clarification: Different tires are designed for different purposes! Winter tires have different tread patterns than summer tires because snow and ice behave differently than dry pavement. Off-road vehicle tires have deeper, more aggressive treads than street car tires. Engineers design specific tread patterns based on the conditions the tire will face, showing that one-size-fits-all doesn't work in tire design.

Extension Activities

1. Friction Shoe Experiment: Have students examine the tread patterns on different types of shoes (sneakers, rain boots, dress shoes). Create a chart comparing the patterns and predicting which shoes would work best on ice, wet floors, and smooth surfaces. Test predictions by sliding shoe soles across different surfaces at angles.

2. Design Your Own Tire: Provide students with paper, clay, or foam circles and have them design and create their own tire tread patterns. Challenge them to think about different environments (desert sand, mountain snow, city streets) and how tread might need to change. Have them explain their design choices using friction as a reason.

3. Water Drainage Investigation: Use two identical shallow pans—one with a smooth plastic sheet and one with a textured surface (like a kitchen scrubber). Pour water on each and observe how the grooved surface allows water to drain differently. Connect this observation to how tire grooves help water escape from under the tire.

Cross-Curricular Ideas

Math Connection: Measuring and Comparing
Have students measure the depth of tire grooves using rulers or measuring tapes. Create a chart showing different tire types (car, truck, bicycle, toy car) and compare the depth of their treads. Challenge students to graph this data and discuss: Which tires have the deepest grooves? Why might that be? Students can use this data to create bar graphs or pictographs showing their findings.

ELA Connection: Persuasive Writing and Safety Campaigns
Ask students to write a short persuasive paragraph or create a poster explaining to younger children why tire tread is important for car safety. They could use the prompt: "Why should people check their tires before a long trip?" This connects the science to real-world communication and helps students practice explaining scientific concepts in a way others can understand.

Social Studies Connection: Community Safety and Responsibility
Explore how tire maintenance connects to community safety. Discuss: Who is responsible for checking tire tread? (car owners, mechanics, inspectors) Why do some places have vehicle inspection laws? Research or invite a local auto mechanic to explain how they check tire tread. This shows students that science knowledge connects to laws, jobs, and keeping communities safe.

Art Connection: Design and Pattern Analysis
Have students create their own original tire tread designs using clay, foam, or drawing materials. Before they design, have them observe and sketch real tire patterns. Challenge them to think about aesthetics (does it look good?) AND function (would it work well in snow? on wet roads?). Display finished designs and have a "tire engineer showcase" where students explain their design choices using friction and traction vocabulary.

STEM Career Connection

Mechanical Engineer / Tire Design Engineer
Tire design engineers use science and creativity to create new tire patterns that work better and last longer. They test different tread designs, materials, and shapes to solve real problems like keeping cars safe on icy roads or making tires that don't wear out too quickly. They use computers to model how tires will perform and work in teams to improve cars. These engineers make sure that when you ride in a car, your tires can grip the road safely no matter the weather.
Average Annual Salary: $90,000–$110,000 USD

Automotive Technician / Mechanic
Auto mechanics inspect, repair, and maintain vehicles, including checking and replacing tires. They measure tire tread depth to see if tires are safe, rotate tires to help them wear evenly, and explain to car owners why tire maintenance matters. They use special tools to balance tires and ensure cars run smoothly and safely. Mechanics combine hands-on problem-solving with knowledge of how different car parts work together.
Average Annual Salary: $40,000–$55,000 USD

Materials Science Technician
Materials scientists study the properties of rubber and other substances used in tires. They test how rubber performs when stretched, heated, or bent, and they experiment with new rubber mixtures that could create better friction or last longer. These scientists help tire companies understand WHY their materials work the way they do, leading to safer, more durable products. They work in laboratories using specialized equipment and data collection.
Average Annual Salary: $45,000–$65,000 USD

NGSS Connections

Performance Expectation:
4-PS3-1: Use evidence to construct an explanation relating the speed of an object to the energy of that object.

Disciplinary Core Ideas:
- 4-PS3.A – Energy can make things move; friction is a force that affects motion
- 4-ETS1.A – Defining and delimiting engineering problems involves understanding the constraints of real-world solutions

Crosscutting Concepts:
- Cause and Effect – Tire tread causes increased friction, which affects how well a vehicle can grip the road
- Structure and Function – The structure (grooves and patterns) of the tire serves the function of improving safety and traction

Science Vocabulary

* Tread: The raised pattern or grooves on a tire that help it grip the road.
* Friction: A force created when two surfaces rub together that can slow things down or help them stick to each other.
* Traction: The ability of a tire or shoe to grip a surface without slipping.
* Groove: A long, narrow valley or channel cut into the surface of a tire.
* Grip: The ability to hold onto or stay attached to a surface.

External Resources

Children's Books:
- How Do Tires Work? by Maria Nelson (Simple explanations with illustrations)
- Trucks by Gail Gibbons (Includes tire design and function)
- Traction Man by Mini Grey (Whimsical story that references grip and movement)