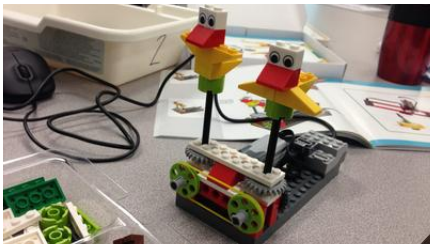
# Engineering

Physical Science | Lesson Guide

2nd Grade

## Photo Description



This image shows LEGO constructions that demonstrate simple machines and engineering design. Students have built colorful structures with wheels, axles, and moving parts, along with figurines that appear to "operate" or interact with the machines. The creations include wheeled vehicles and articulated characters, showing how building blocks can be combined to create moving objects.

## Scientific Phenomena

Anchoring Phenomenon: How can we build things that move?

Students are observing and creating examples of simple machines in action—specifically wheels and axles. When wheels spin around an axle (the rod through the center), they roll and help objects move more easily. The figurines demonstrate that machines can be designed to perform tasks or actions. This is happening because of friction and force—the wheels reduce friction between the structure and the surface, making movement possible with less effort. Engineering is the practical application of science to solve real-world problems, and these student designs show how planning, building, and testing lead to working solutions.

## Core Science Concepts

* Simple Machines (Wheels & Axles): A wheel is a circular object that spins around a center rod called an axle. Wheels help things move smoothly and reduce the effort needed to move heavy objects.

* Force and Motion: A force is a push or pull that makes things move. When students build with wheels, they are using force to make their machines go forward, backward, or spin.

* Engineering Design Process: Engineers plan, build, test, and improve their creations. These LEGO structures show students thinking like engineers—they designed what they wanted to build, constructed it with materials, and tested whether it works.

* Structure and Stability: Building something that stands up and moves requires understanding how to balance pieces and connect them securely. Different building choices affect whether a machine works well or falls apart.

**Pedagogical Tip:**

Before this lesson, have students predict what will happen when the wheel spins. After building, have them observe and compare their predictions to what actually occurred. This "predict-observe-compare" routine builds scientific thinking habits and metacognition. Encourage students to say things like, "I thought the wheel would roll fast, but it rolled slow because..." This honors their ideas while deepening their understanding of cause and effect.

**UDL Suggestions:**

Multiple Means of Representation: Provide visual building instruction cards with pictures (not just words) so students can follow along. Use actual models or videos showing wheels spinning, not just verbal descriptions.

Multiple Means of Action & Expression: Allow students to show their learning through building, drawing labeled diagrams, or physically demonstrating how their machine works—not just writing or talking about it.

Multiple Means of Engagement: Let students choose what machine they want to build (a car, a spinner, a pusher) so they feel ownership. Celebrate effort and creative problem-solving, not just "perfect" results.

## Zoom In / Zoom Out

Zoom In: Friction at the Microscopic Level
When a wheel spins on an axle, the surfaces are touching and rubbing together. If we could zoom in really, really close—like with a super-powerful microscope—we'd see that both the wheel and the axle have tiny bumps and ridges (even though they look smooth to our eyes). These tiny bumps rub against each other and create friction, which is a force that tries to slow things down. That's why wheels with smoother surfaces roll better than rough ones—fewer bumps mean less friction! Engineers choose smooth materials to help machines move more easily.

Zoom Out: Machines in Transportation Systems
These simple LEGO machines are just like the bigger machines we see every day in our community. Think about cars, buses, bicycles, and shopping carts—they all use wheels and axles to move people and things from place to place. When you zoom out and look at an entire city, all of these wheeled machines work together in a transportation system. Roads, parking lots, and traffic rules all exist because we've engineered machines with wheels to help us travel. Even bigger: wheels and axles help move cargo ships, airplanes, and trains that connect our whole world! This simple machine is the foundation for how humans move around on Earth.

## Discussion Questions

1. What happened when you spun the wheel? (Bloom's: Remember | DOK: 1)
   Students describe the observable motion.
2. Why do you think the wheels helped your machine move? (Bloom's: Explain | DOK: 2)
   Students begin reasoning about function and purpose.
3. If you wanted your machine to move faster, what could you change or build differently? (Bloom's: Analyze | DOK: 2)
   Students think critically about cause-and-effect relationships and redesign.
4. How is your machine like real machines you see every day (like a toy car or a shopping cart)? (Bloom's: Apply | DOK: 3)
   Students connect classroom learning to the world outside school.

## Potential Student Misconceptions

Misconception 1: "Wheels move by themselves."
Clarification: Wheels don't move on their own—they need a force (a push or pull) to make them spin. In these LEGO machines, students must push or give the wheel energy to make it turn. Help students recognize that someone or something has to do work to make the wheel move. Ask: "What made the wheel spin? Did you push it, or did it move all by itself?"

Misconception 2: "Bigger wheels are always better."
Clarification: Students may think that larger wheels always make machines faster or "better." In reality, wheel size affects how fast something moves and how much force you need, but "better" depends on what job you want to do. A big wheel might roll far with one push, but a small wheel might be easier to control. Help students test different wheel sizes and compare: "Did the big wheel or small wheel move faster? Which one was easier to push?"

Misconception 3: "The axle is just a stick holding the wheel up."
Clarification: Students might see the axle as merely a support rod rather than a functional part of the machine. In fact, the axle is the center point around which the wheel rotates. Without the axle, the wheel couldn't spin smoothly. Demonstrate by showing a wheel without an axle (it falls apart or drags) versus one properly attached (it spins freely). Say: "The axle is the helper that lets the wheel spin around and around!"

## Extension Activities

1. Design Your Own Machine Challenge: Give students a new building challenge: "Build a machine that pushes something across the table" or "Build a machine that spins." Have them sketch their plan first, build it, test it, and explain what worked or what they would change. This reinforces the engineering design cycle.

2. Wheel Race: Set up a simple race track. Have pairs build two different wheel designs (big wheels vs. small wheels, or wheels close together vs. far apart) and predict which will move faster. Race them and discuss results. Students see how design choices affect performance.

3. Real-World Machine Hunt: Take students on a "machine walk" around the school or classroom. Find and photograph/ sketch real wheels and axles (door handles, shopping carts, toy bins on wheels, playground equipment). Create a class poster showing "Wheels & Axles We Found!" connecting engineering to everyday life.

## Cross-Curricular Ideas

Math Connection: Measuring and Comparing Wheels
Have students measure the wheels and axles in their machines using non-standard units (like LEGO studs or paper clips) and standard units (like inches or centimeters). Create a simple chart comparing wheel size to how far the machine rolled. This reinforces measurement, data collection, and the relationship between size and distance—early mathematical thinking about variables and patterns.

ELA Connection: Engineering Storytelling
Ask students to write or dictate a simple story about their machine character (like the LEGO figures in the photo). "What does your machine do? Who does it help? What problem does it solve?" This combines engineering with narrative writing. Students can illustrate their stories and create a class book titled "Our Machines and Their Missions," connecting creative expression to functional design.

Social Studies Connection: Community Helpers & Tools
Discuss how different workers in the community use wheeled machines: postal workers deliver mail in trucks, construction workers use wheelbarrows, garbage collectors use large trucks, and farmers use tractors. Have students draw or discuss which community helpers use machines with wheels. This builds awareness of how engineering and simple machines are essential to jobs that help our neighborhoods.

Art Connection: Designing & Decorating Machines
After building a functional machine, invite students to add decorative elements—paint, stickers, or colored paper—to make it visually interesting. This teaches that engineers must balance function (does it work?) with form (does it look good?). Students learn that real-world machines are designed to be both useful and appealing, introducing the concept of design thinking beyond just "making it work."

## STEM Career Connection

Mechanical Engineer
A mechanical engineer designs and builds machines that move and work—like cars, bicycles, robots, and playground equipment. They use wheels, axles, and other simple machines to solve problems. If you love building things with LEGO and making them move, you might grow up to be a mechanical engineer! They spend time drawing plans, building models, and testing to make sure machines work safely and well.
Average Annual Salary: ~$90,000 USD

Toy Designer / Product Engineer
Toy designers create the LEGO sets, action figures, toy cars, and games that kids play with every day. They think about what children would enjoy, how to make toys safe and fun, and how wheels, gears, and moving parts can make toys more exciting. This job combines imagination with engineering—you get to play with toys and invent new ones!
Average Annual Salary: ~$75,000 USD

Transportation Engineer
Transportation engineers design the roads, vehicles, and systems that help people and things move around cities and towns. They work on cars, buses, trains, bicycles, and even airports. They think about wheels, speed, safety, and how to move lots of people efficiently. If you like machines that go places, this could be your career!
Average Annual Salary: ~$87,000 USD

## NGSS Connections

Performance Expectation:
K-2-ETS1-1: Ask questions, make observations, and gather information about a situation that people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

Disciplinary Core Ideas:
- K-2-ETS1.A — Define a simple design problem
- K-2-ETS1.B — Develop a simple solution through the engineering design process

Crosscutting Concepts:
- Cause and Effect — When wheels spin, the object moves (cause !’ effect)
- Structure and Function — The shape and arrangement of wheels and axles determine how the machine works

## Science Vocabulary

* Wheel: A round, flat piece that spins around a center rod to help things move smoothly.

* Axle: The rod or stick that goes through the center of a wheel and lets it spin.

* Machine: A tool made of parts that work together to do a job or make something move.

* Engineer: A person who designs and builds machines or structures to solve problems.

* Force: A push or pull that makes something move, stop, or change direction.

* Simple Machine: A basic tool with few or no moving parts that helps us do work more easily.

## External Resources

Children's Books:
Simple Machines* by David Adler (explains wheels, levers, and pulleys in kid-friendly language)
How Do Wheels Work?* by Christopher Harbo (part of the "How It Works" series, with clear illustrations)
Rosie Revere, Engineer* by Andrea Beaty (inspiring story about a girl who loves to build and solve problems)
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Instructional Note: This lesson sequence works best as a 2–3 day unit. Day 1: Introduce wheels/axles with the image and discussion. Day 2: Student building time with the engineering design process. Day 3: Testing, sharing, and reflection. Scaffold student thinking by asking, "What do you notice?" before "Why do you think that happened?"