Friction

Physical Science | Lesson Guide

5th Grade

Photo Description

This image shows a modern electric train called a light rail or metro train. The train is white and gray with large windows and runs on metal tracks. You can see overhead power lines and poles that provide electricity to make the train move without using gasoline or diesel fuel.

Scientific Phenomena

The anchoring phenomenon here is electromagnetic energy transfer and conversion. The train receives electrical energy through overhead wires and converts it into mechanical energy (motion) using electric motors. This demonstrates how energy can be transferred from one place to another and transformed from one type to another. The electric current flows through the overhead lines, down through the train's pantograph (the metal arm on top), powers the electric motors, and creates the magnetic forces that turn the wheels and move the train forward.

Core Science Concepts

1. Energy Transfer and Transformation: Electrical energy travels through power lines and gets converted into mechanical energy (motion) by the train's electric motors.

2. Electromagnetic Forces: Electric motors use magnetism and electricity working together to create the force that moves the train wheels.

3. Sustainable Transportation: Electric trains produce no direct air pollution and can use renewable energy sources like solar or wind power.

4. Circuit Systems: The train, tracks, and overhead wires form a complete electrical circuit that allows current to flow and power the vehicle.

Pedagogical Tip:

Have students trace the energy pathway from the power source to the moving train using hand gestures or drawing arrows. This kinesthetic approach helps them visualize the invisible energy transfer process.

UDL Suggestions:

Provide multiple ways for students to represent their understanding: some can draw energy flow diagrams, others can build simple circuit models, and kinesthetic learners can act out the energy transformation process through movement.

Zoom In / Zoom Out

1. Zoom In: Inside the electric motor, flowing electrons create magnetic fields that interact with permanent magnets, causing the motor shaft to rotate. This electromagnetic induction happens at the atomic level as electrons move through copper wire coils.

2. Zoom Out: This electric train is part of a larger transportation network that connects to the electrical grid, which may include power plants using renewable energy sources like solar farms or wind turbines, contributing to reduced carbon emissions across entire cities.

Discussion Questions

1. How does the energy travel from the power lines to make the train wheels turn? (Bloom's: Analyze | DOK: 2)

2. What advantages might electric trains have over trains that burn fossil fuels for our environment? (Bloom's: Evaluate | DOK: 3)

3. If you could design an electric vehicle, what energy source would you use and why? (Bloom's: Create | DOK: 4)

4. What would happen if the connection between the train and the overhead wire was broken? (Bloom's: Apply | DOK: 2)

Potential Student Misconceptions

1. Misconception: "The train gets power from batteries like a toy car."
Clarification: Electric trains receive continuous power from overhead wires or electrified rails, not from batteries stored on the train.

2. Misconception: "Electric trains are slower than regular trains."
Clarification: Electric trains can actually be faster and more efficient than diesel trains because electric motors provide instant power and have fewer moving parts.

3. Misconception: "The electricity in the wires is the same as in house outlets."
Clarification: Train power systems use much higher voltage electricity (thousands of volts) compared to household electricity (120 volts), which is why there are safety barriers and warning signs.

Cross-Curricular Ideas

1. Math - Data Analysis & Graphing: Have students research the speed of electric trains versus diesel trains and create bar graphs comparing their speeds. They could also calculate how long it takes a train to travel certain distances at different speeds, applying multiplication and division skills.

2. ELA - Persuasive Writing: Students write a persuasive letter to their city council explaining why electric trains would be good for their community. They can use facts about pollution reduction, energy efficiency, and safety to support their arguments.

3. Social Studies - Urban Planning & Community Design: Explore how cities plan transportation systems and where train stations are built. Students can map out a route for a new light rail system in their town, considering neighborhoods that need better transportation access.

4. Art & Engineering Design: Students design and build model electric trains using craft materials and simple circuits with battery-powered motors. They can decorate their models and create a miniature city landscape with tracks, stations, and overhead power lines.

STEM Career Connection

1. Electrical Engineer - These scientists and engineers design and build electrical systems for trains, including the motors, power systems, and safety features. They figure out how to make trains faster and more efficient while keeping them safe. Average Annual Salary: $110,000 USD

2. Mechanical Engineer - These professionals design the physical parts of trains like the wheels, brakes, doors, and the overall structure. They make sure all the moving parts work smoothly together so the train runs safely and comfortably. Average Annual Salary: $95,000 USD

3. Renewable Energy Technician - These workers install and maintain solar panels, wind turbines, and other systems that generate clean electricity to power electric trains. They help make sure trains get power from sources that don't pollute our air. Average Annual Salary: $58,000 USD

NGSS Connections

- Performance Expectation: 5-PS1-3 - Make observations and measurements to identify materials based on their properties
- Disciplinary Core Ideas: 5-PS3.B - Energy transfer and 5-ESS3.C - Human impact on environment
- Crosscutting Concepts: Energy and Matter and Cause and Effect
- Science and Engineering Practices: Developing and using models, Planning and carrying out investigations

Science Vocabulary

* Electric motor: A machine that uses electricity and magnetism to create motion
* Energy transformation: The process of changing energy from one type to another
* Conductor: A material that allows electricity to flow through it easily
* Electromagnetic: Having to do with both electricity and magnetism working together
* Renewable energy: Energy that comes from sources that won't run out, like sunlight or wind
* Circuit: A complete path that allows electricity to flow from one place to another

External Resources

Children's Books:
- "Energy Makes Things Happen" by Kimberly Brubaker Bradley
- "Electric Trains" by Cari Meister
- "The Magic School Bus and the Electric Field Trip" by Joanna Cole