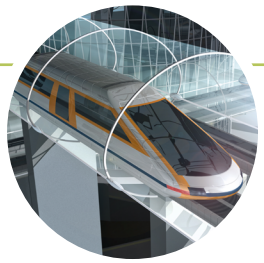
Engineering an Electromagnetic Train

A Carolina Essentials™ Activity

Student Worksheet



Overview

Trains have been transporting people and goods for hundreds of years. Early trains used steam engines fueled by wood or coal. Today, trains run on petroleum diesel, electricity, or electromagnetic propulsion. Interest is high in trains that do not require the combustion of fossil fuels, decreasing releases of carbon dioxide into the atmosphere.

Magnetically levitated (maglev) trains do not have an engine but are propelled by a magnetic field created by electric coils in the track and guideway walls. Look at the picture below to see the side rails. Because the train is elevated, friction is minimized, making the ride smooth and quiet for passengers. The Central Japan Railway Company is pioneering high-speed maglev train systems to run throughout Japan.

High-Speed Maglev Train, Yamanashi, Japan

The goal of this engineering design activity is to create a model maglev train and maximize its speed, much like the early models engineers used to design the current maglev systems.

SAFETY REQUIREMENTS

No PPE is required for the activity.

MATERIALS

Copper wire, 12 ft

2 batteries, size AA

4 neodymium magnets, $^1/_2 \times {}^1/_4$ in

Stopwatch or smartphone

Metric ruler or measuring tape

Your Engineering Problem

How can we move people quickly and minimize burning fossil fuel?

Essential Question

How can magnetic and electric fields be used to engineer a vehicle?

Activity Objectives

1. Engineer a device that can transport a battery like a train car.
2. Maximize the speed of the train car.

Activity Procedures

1. Your task is to construct a coil that will conduct a battery as quickly as possible through the coil. You will work with these variables:
   - Length of the coil (length of the wire cannot change, but the tightness and size of coils can change)
   - Number of batteries
   - Number and placement of magnets
2. Data must include the speed of the train car—distance traveled in centimeters and time in seconds.
3. Keep a detailed log of the variables you changed with data.

Continued on the next page.

4. Include a picture of the final setup.
5. Include data for at least 3 runs of your final design and calculate the average final speed.

Data and Observations

Construct a data table that identifies the variables you are changing (independent), the variables you are holding constant (controlled), and the variables you are measuring (dependent).

Insert the data table here. Remember to include units for all numbers.

Insert the picture of the final setup here.

Analysis and Discussion

1. Describe your final design, explain how it works, and use evidence to make a claim that it was the best design.

2. Identify the variables that were the most impactful on the final design, and supply evidence for the variable impact on the design.