How Maglev Trains Work

The Shanghai Maglev travels 267 miles per hour. It can travel 19 miles in just seven minutes!

Maglev trains are some of the world's fastest trains. They can reach speeds of 400 miles per hour(mph)! Aside from going fast, these trains are smoother, quieter, and use about 30% less energy than regular trains. So, how do they accomplish all of this?

Maglev is short for magnetic levitation. Maglev trains use the physical forces of magnetism and electromagnetism to not only levitate the train, but to push and pull it forward. Maglev trains are a great example of how engineers use science to design an incredible piece of technology.

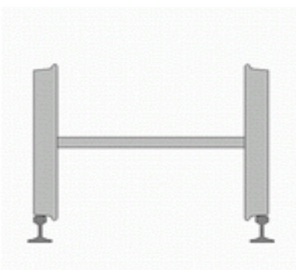
World's Fastest Trains

Train	Country	Speed
Shanghai Maglev	China	267 mph
Harmony CRH380A	Denmark	236 mph
Trenitalia Frecciarossa 1000	Italy	220 mph
Renfe AVE	Spain	217 mph
DeutscheBahn ICE	Germany	205 mph
Eurostar e320 and TGV	England, France, Belgium	201 mph
Hayabusa Shinkansen E5	Japan	200 mph
Thalys	Holland	186 mph
Hokuriku Shinkansen E7	Japan	161mph
Amtrak Acela Express	United States	150 mph

Diesel and Electric-Powered Trains

Most trains in the United States are powered by either diesel gasoline or electricity; and if you have ever ridden on one, you know that they are noisy. That's because these types of trains have steel wheels that run on steel tracks.

Trains use the force of friction to slow them down. Friction is created when surfaces slide against one another. When a train engineer applies the brakes, the friction created from the steel wheels sliding against the steel tracks produces a loud screech! In train-speak that's called rail squeal.



Conical Train Wheels

Diesel and electric-powered trains are also quite bumpy. That's because of the conical shape of the train's wheels. Train wheels are designed this way to help them make turns. As the wheels move from side-to-side along the track, they make for a bumpy ride.

Finally, even though diesel and electric-powered trains are more fuel-efficient than trucks, they still use a lot of energy. In 2016, freight trains consumed about 3.4 billion gallons of diesel fuel.

Commuters board Long Island Railroad.

Track Facts

In 2016, freight trains in the United States transported nearly one and a half billion tons of freight.

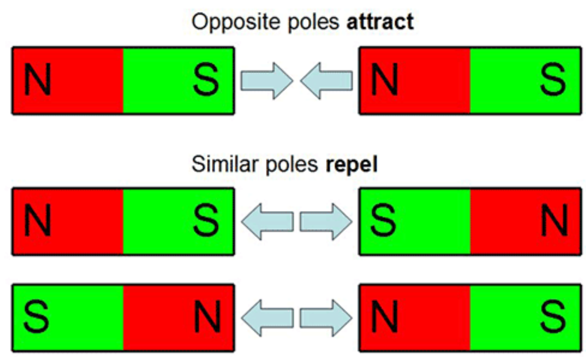
In the United States, about one and a half million people take a commuter train to work every day.

Magnetism

Lodestones are natural magnets. It is through the discovery of lodestones, that people first discovered magnetism in the 6th century BCE.

Permanent magnets are objects made of iron, nickel, or cobalt that exist naturally on Earth. These types of magnets produce a force called magnetism. Magnetism is one of the forces engineers use to design and build maglev trains.

If you have ever experimented with magnets, you know that they have both a north and a south pole. The poles of a magnet can either attract other magnets towards them, or push them away.



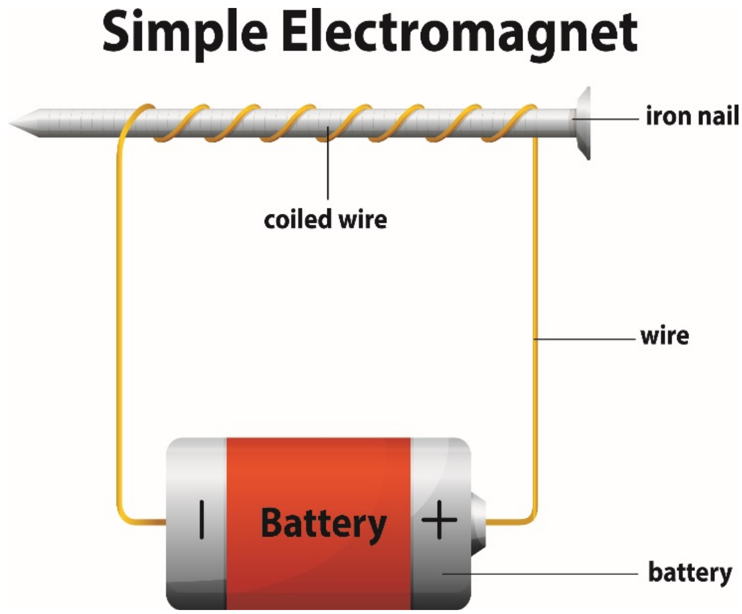
The opposite poles of a magnet will pull towards each other or attract: poles that are the same will push away from each other or repel.

Electromagnetism

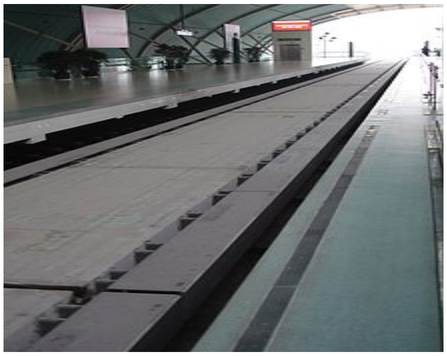
Electromagnets are magnets that get their magnetism from a moving electrical charge. Electromagnets produce a force called electromagnetism. Electromagnets do not produce a permanent magnetic force. The magnetism they produce is temporary, and can be switched off and on depending upon what is required. Engineers use electromagnetism in the design and construction of maglev trains.

Batteries, like the one pictured here, store electrical energy. If you attach a wire to the ends of the battery, you will create a path through which that electrical energy can flow. If you wrap the wire around an iron nail, the electrical energy will flow around the wire and magnetize the nail.

If, however, you disconnect one end of the wire from the battery, the electrical flow will stop and the nail will no longer be magnetized.



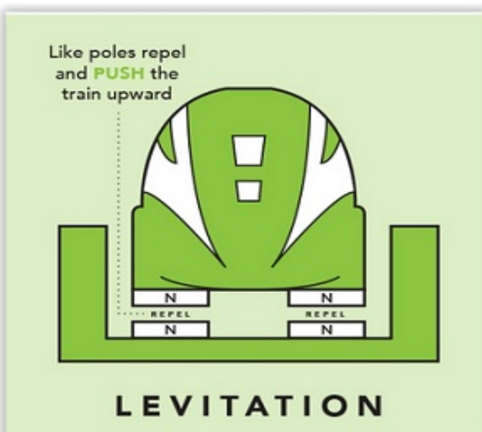
This junkyard crane uses an electromagnet to move scarp metal.



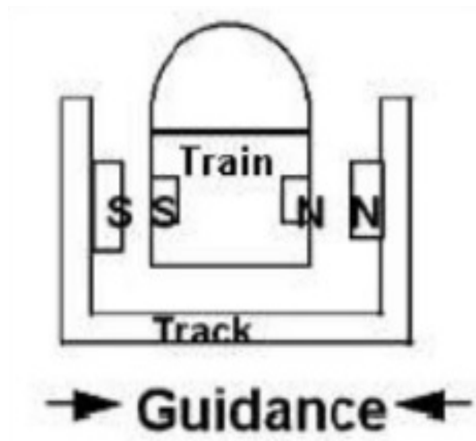
Maglev Guideway: Shanghai, China

No Track Trains

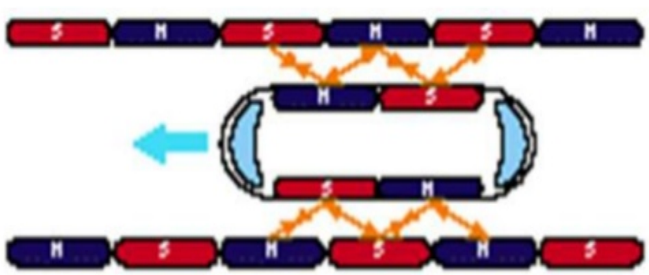
Maglev trains do not have steel wheels and do not run on steel tracks. Instead, they operate on guideways. While there are a few different types of maglev trains, they generally operate the same way. Study the illustrations below to learn how electromagnetism is used to operate a maglev train.



On a levitated train, the force of friction is greatly reduced, making the ride faster and smoother.



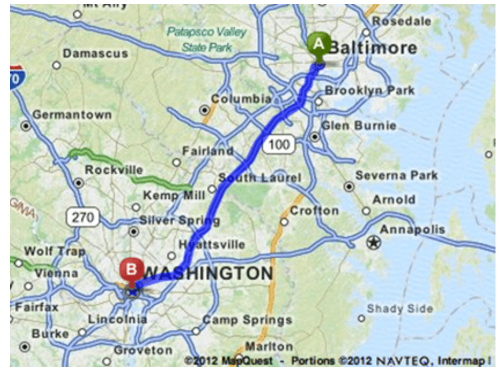
Powerful electromagnets are used to keep the train centered over the guideway. Remember, like poles in a magnet repel.



Electromagnets along the guideway and the sides of the train push and pull the train forward. Electromagnets can be switched on and off as needed.

While there are many advantages of maglev trains, there is also one large disadvantage. They are very expensive to build. Because maglevs do not use traditional steel tracks, new guideways would have to be constructed, in addition to building the trains that run on electromagnetism.

Currently, there is a proposal to build a maglev train from Washington, D.C. to Baltimore, Maryland. The new train would cut the current travel time from 30 minutes to 15 minutes. The estimated cost for the project however is between 10 to 15 billion dollars.



It is roughly 38 miles from Baltimore, Maryland To Washington D.C.

Amtrak, the United States' national passenger railroad, has roughly 22,000 miles of train track. With an estimated cost of about 50 to 200 million dollars to build one mile of guideway, it is unlikely that we will have a system of maglev trains anytime soon.

Vocabulary

1. **electromagnetism:** magnetic force created by the flow of an electrical current

2. **electromagnets**: a magnet that gets its magnetism from a moving electrical charge

3. **friction**: force created when surfaces or objects slide against one another

4. **guideway**: magnetic path on which a maglev train travels

5. **maglev**: short for magnetic levitation

6. **magnetic levitation**: the use of electromagnets to levitate and propel a maglev train

7. **magnetism:** natural physical force created by magnets that attract or repel one another

8. **permanent magnet:** an object made iron, nickel or cobalt that retains its magnetism

9. **rail squeal**: sound a train makes when braking