

AmplifyScience

HOVERBOARD



by Jonathan Curley

illustrated by Alex Aranovich
and Juan Tenorio

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SAMPLE

A Floating Skateboard

Imagine yourself standing on a board. The board is shaped like a skateboard, but it has no wheels. Also, it isn't touching the ground—instead, it is floating in the air just above the ground! It is not a skateboard. . . . It is a hoverboard! (The word **hover** means “float.”) By leaning one way or another, you control the hoverboard. It floats this way and that over the hoverboard ramp.



Different teams of **engineers** are working to **design** hoverboards and hoverboard ramps. Before hoverboards can be sold, engineers have to make sure they are safe. Designing a hoverboard that is safe for every rider, every time, is the hardest part. Before the hoverboard is ready for the public, the engineers have to test these hoverboards hundreds of times. They will also try to figure out how to build hoverboards that won't cost too much. Depending on how hard this turns out to be, you may soon see people floating on hoverboards in a park in your town or city!

A hoverboard may seem like magic, but it isn't. Engineers use scientific ideas about **magnets**, **gravity**, and **forces** to design hoverboards.

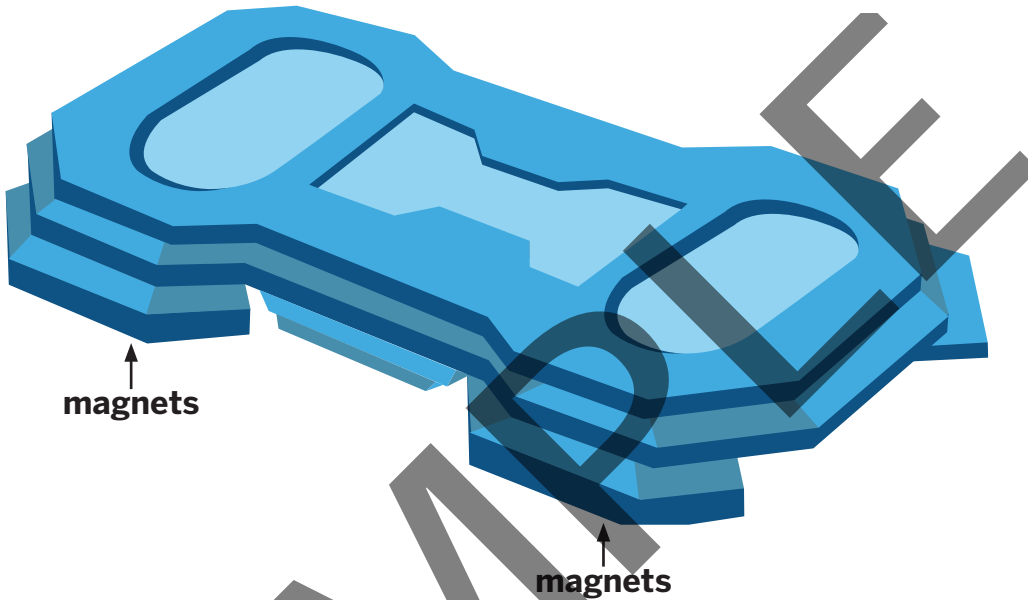




What Pushes the Hoverboard Upward?

Why does the hoverboard float above its ramp? The answer has to do with **magnetic force**. Magnets can **exert** forces on other magnets and on **objects** made of certain materials such as iron. Magnets do not need to touch an object in order to push or pull on the object. They can exert a force from a distance.

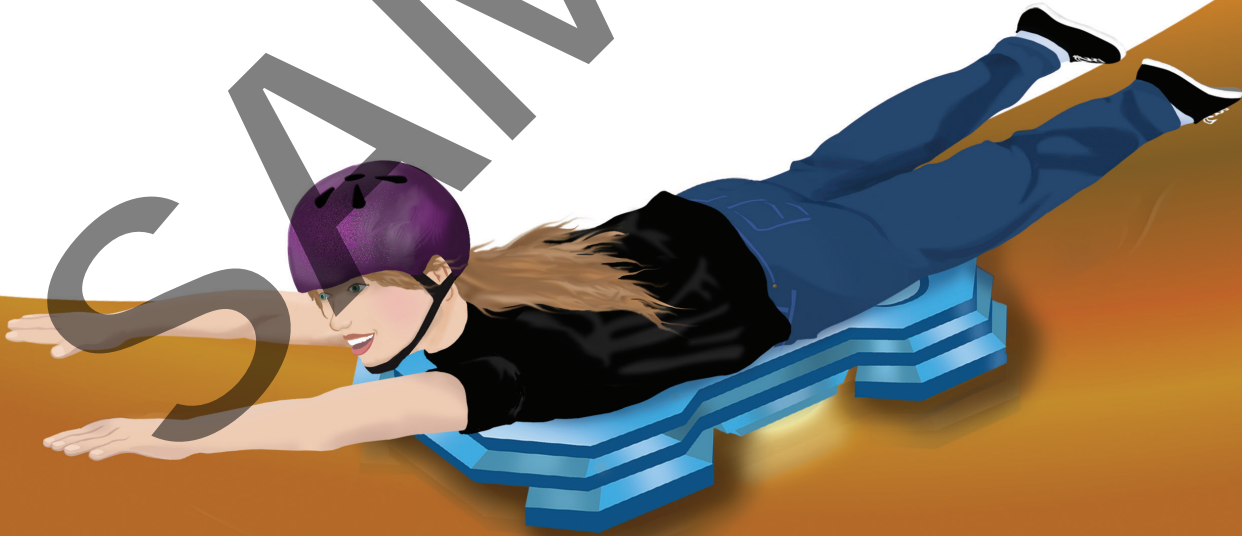
Hoverboards float in the air because of magnets that repel.



Two magnets can **attract** one another—that means they pull together. Sometimes two magnets **repel** each other—they push apart. Hoverboards use magnets that repel to hover. When a hoverboard floats, it is actually repelling with magnetic force.

What Pulls the Hoverboard Downward?

The repelling magnets are pushing the hoverboard upward, away from its ramp. Think about this: Why does the hoverboard float just a little above the ramp? Why doesn't the repelling force of the magnets push the board higher and higher until it floats away? It's because magnets are not the only objects exerting a force on the hoverboard.





Earth pulls objects (including hoverboards) downward with the force of gravity.

There's something pulling the board downward: Earth. Earth
There's something pulling the board downward: Earth.
Earth actually pulls everything toward its center. This force
is called gravity!

Why Does the Hoverboard Float?

The repelling magnets push the hoverboard away from the ramp with magnetic force. Earth pulls the hoverboard down toward the ramp with the force of gravity. The engineers who are designing hoverboards work to make sure these two forces (gravity and magnetic force) are balanced. Two forces are balanced when they are in opposite directions and each force has the same strength. This is a hard job for the engineers. The forces need to be balanced whether there is a light ten-year-old on the board or a heavy teenager. Using the science of **balanced forces**, engineers will soon be able to make sure the forces will always cause the board to hover when they want it to, no matter who is riding it.



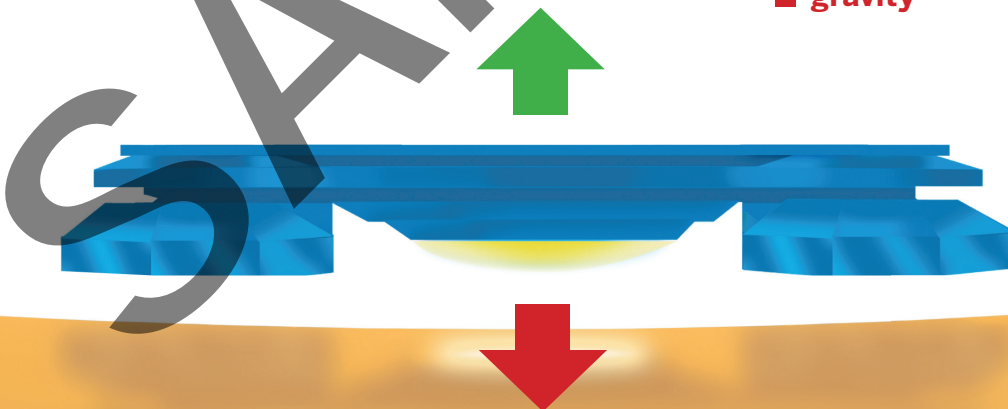
Sometimes people get confused and think that, if an object is not moving, no forces can be acting on it. That's not true. The floating board is not moving any higher or lower, but there are still objects exerting forces on the board. The hoverboard stays still because the upward magnetic force on the board is in balance with the downward force of gravity.

Here is a similar situation. A girl is holding up a heavy barbell. The weight is not moving, but forces are still acting on the barbell. The girl is pushing up hard on the barbell. She is exerting a force to hold up the barbell. Earth is pulling down on the barbell with just as much force. The barbell is not moving because the two forces are balanced.

Balanced Forces

When the electromagnets are turned on, the hoverboard floats.

- magnetic force
- gravity



Why Does the Hoverboard Come Down?

The forces acting on the hoverboard are not always balanced. You can turn a hoverboard on and off. When the hoverboard is turned off, it drops down onto the ramp. It does not float anymore. Why not?

Some kinds of magnets can be turned on and off. These are called electromagnets. The magnets in the hoverboard are a type of electromagnet.

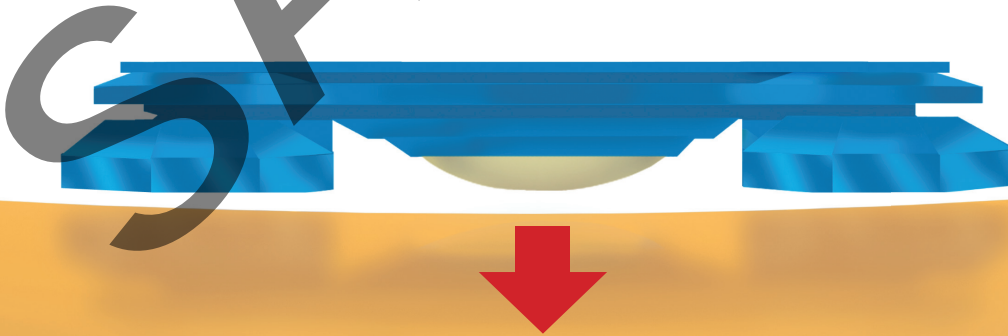


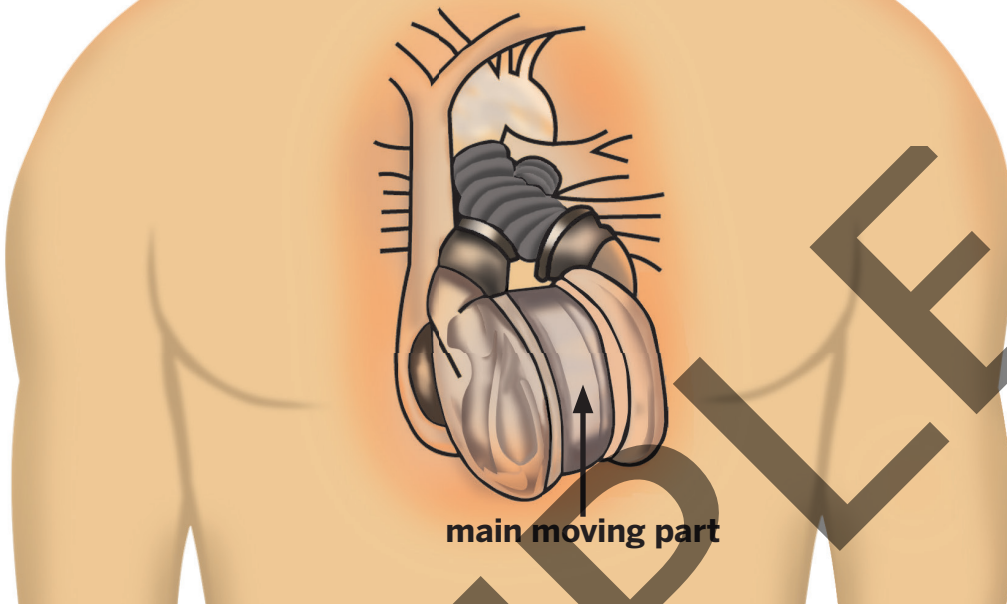
When the hoverboard is turned off, the magnets are turned off. The magnets no longer repel. The magnets are not pushing the board up any more, but Earth is still pulling the board down. You can't turn off gravity! The forces are **unbalanced**, so the board moves. It falls down a short way until it rests on the ramp.

Unbalanced Forces

When the electromagnets are turned off, the hoverboard starts to fall.

■ gravity

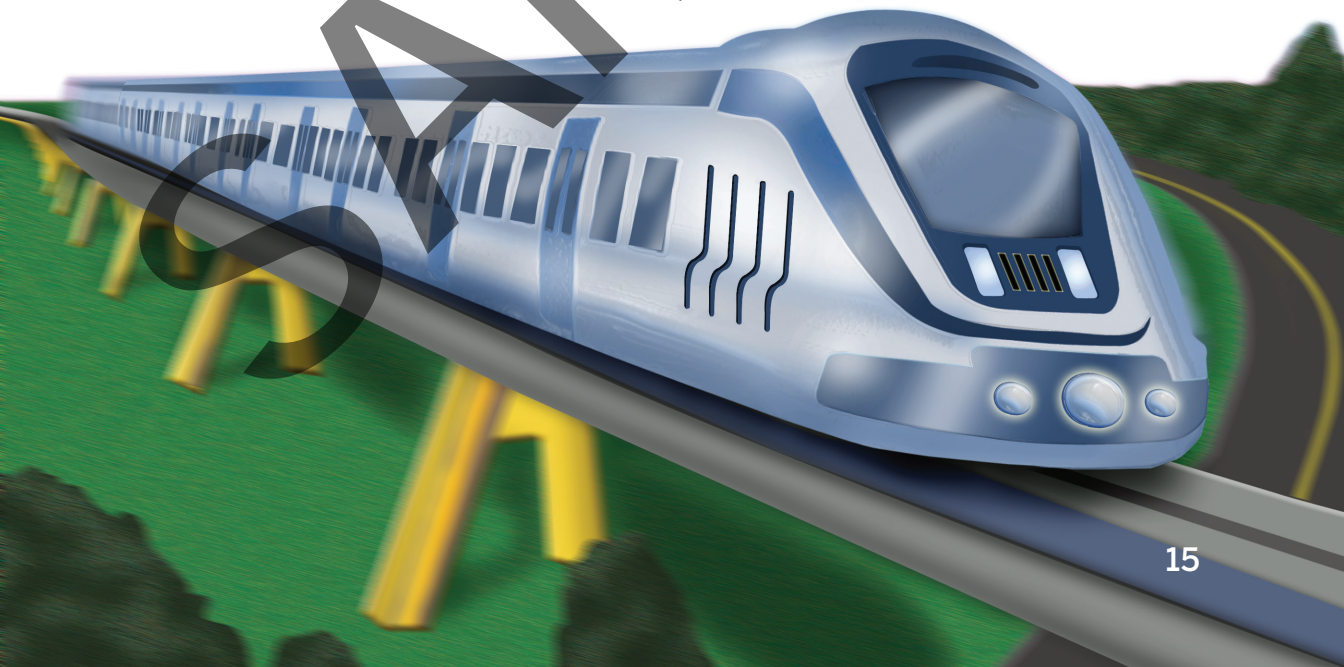




Other Inventions with Balanced Forces

The hoverboard is not the only invention to use balanced forces. Engineers have designed an artificial heart that can be put inside a person whose heart doesn't pump blood well. The main moving part of the heart floats without touching anything! It is held by balanced forces of magnets: one magnet pulling it one way, and another magnet pulling the opposite way. This artificial heart lasts longer than others because its parts don't rub against each other.

Can you think of another way magnets and balanced forces could be used in an invention? What is another reason you might want something to float without touching anything?



Glossary

attract: to pull on an object, even without touching it

balanced forces: multiple forces of equal strength acting on an object

design: to try to make something new that solves a problem

engineer: a person who uses science knowledge to design something in order to solve a problem

exert: to cause a force to act on an object

force: a push or a pull

gravity: the pull between Earth and other objects, which acts even without touching

magnet: an object that pulls on some kinds of metal and pushes and pulls on other magnets, even without touching them

magnetic force: the push or pull between two magnets, or the pull of a magnet on some kinds of metal

object: a thing that can be seen or touched

repel: to push on an object, even without touching it

unbalanced forces: multiple forces of unequal strength acting on an object

Books for *Balancing Forces*:

Forces All Around

What My Sister Taught Me About Magnets

Hoverboard

Explaining a Bridge

Handbook of Forces

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Balancing Forces

Do floating skateboards really exist?

It seems like something from a movie, but floating skateboards are real! They are called hoverboards and they work because of magnetic force and gravity. Learn all about this awesome invention and how balanced forces make it possible.



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