

# SYSTEM ALERT!

Tomorrow is almost here.

## Gears get the job done

In 1901, a fascinating artifact was recovered from an ancient shipwreck: the Antikythera device. It has been called the world's oldest computer. It was used by Greeks thousands of years ago to track the motion of planets and moons. Because it is broken into fragments and corroded by time, we must use our imaginations to see it as it once was. But even in its original glory it looked nothing like a computer as we think of one today.

The device used interlocking gears to accomplish its purpose. Gears are an ancient technology, but they are still very relevant to our lives today. The function of gears is to transfer force from one place to another. Turn one gear and it turns other interlocking gears.

The gears shown here are from the TETRIX® robotics system from Pitsco. But these same kinds of gears can be found in many devices.



Gears are more than 2,000 years old but are still relevant today. (Image courtesy of Marsyas, Wikimedia)



### SPUR GEARS

Spur gears are very common. The teeth of two spur gears connect on the same plane. When one turns, it causes the other to turn in the opposite direction. Changing the size of one gear in relation to another can speed up or slow down motion. Many of these gears can be linked together. They can be found in bicycles, washing machines, mechanical clocks, and blenders. At high speeds, these gears are noisy. ⚠



### WORM GEARS

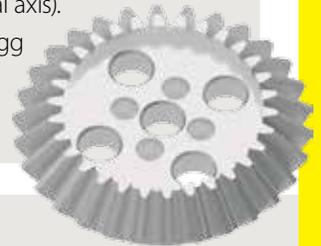
In a worm gear setup, the teeth of a gear are meshed with a screw thread on a shaft – called the worm. As the worm turns, the gear turns. This can be used to drastically change the speed of motion. In a lawn sprinkler, the force of the water entering the device from the hose drives a turbine, which ultimately powers the back-and-forth movement of the spray tube. Worm gears slow down this motion so the spray tube doesn't move wildly back and forth. ⚠



**CHECK OUT:**  
Check out cool TETRIX projects at Pitsco.com.

### BEVEL GEARS

When you need to change the angle of a force, bevel gears might do the trick. These are normally positioned at a 90-degree angle to one another. Bevel gears are used in hand drills. The handle is turned on the side of the device (on a horizontal axis), and in response the drill bit rotates at an angle 90 degrees apart (on a vertical axis). Bevel gears are also used in egg whisks, the differential in a car, and printing presses. ⚠



### RACK AND PINION

A rack and pinion converts rotation into linear (along a straight line) motion. The teeth of the round gear engage the teeth of the rack, a straight piece that moves back and forth. Many cars use a rack and pinion, combined with a lever, to allow the steering wheel to change the angle of the wheels. ⚠



# Levitation now

Levitation has long been a hallmark of future societies in science fiction. But this technology of tomorrow is here today – and has been with us for quite some time. Only recently, however, has levitation technology begun to appear in homes and classrooms across the country.

What goes up must come down. This is true for one reason: gravity. Scientists consider gravity to be a weak force. “How can that be?” you might ask. “Gravity keeps my feet planted on Earth.” Yes, but Earth is massive, so it has a lot of attractive power. Compare that to a magnet, which has a strong pull even though it is quite small. (Though the magnet’s power can’t compete with gravity for reach. The gravity of every object affects every other object in the universe, no matter how far away.)

Gravity must be resisted to levitate an object. Another force must act on the object in an opposite direction from gravity, pushing it away from Earth’s surface. There are many ways to do this. Let’s look at a few applications.

## Maglev vehicles

Friction is the enemy of speed. Maglev trains use powerful magnets to levitate a train above the track, eliminating much friction. Most maglev designs use both the attractive and the repulsive power of magnets.

When it comes to magnets, opposite poles attract and like poles repel. You might think levitating trains would only make use of the repulsive power of magnets. But the most common type of maglev system, called electromagnetic suspension, uses a delicate balance of attractive and repulsive forces to hold the train off the ground. ⚠️



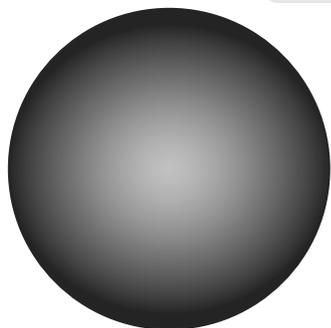
CHECK OUT:  
[Pitsco.com/maglev\\_II\\_track](https://Pitsco.com/maglev_II_track)

Attracted to maglev vehicles? The Pitsco Levitator Maglev Vehicle Kit and track use the repulsive power of magnets to levitate a card-stock vehicle. For a slightly more advanced (and authentic) ride, try the Maglev II Track, which uses an electric current to propel the vehicles. ⚠️



## Speakers

The jury is still out on the sound quality of levitating speakers, but these devices are definitely guilty of being cool. Strong magnets with opposing polarities cause the speaker and the base to repel one another. The result? Levitation! The first levitating speaker was the OM/ONE. Since then, numerous options have come to the market. In 10 years, will we look back on this as a fad, or will we see this as the entry point for levitation in our homes? ⚠️



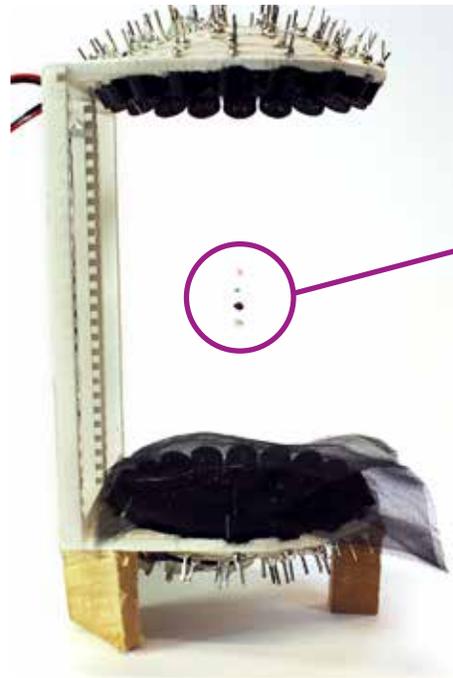
# Acoustic levitation

Magnets aren't the only means for levitating objects. Would you believe that sound can do the trick?

Sound happens when the vibration of an object causes air molecules to bump into one another, ricocheting back and forth in waves, creating high-pressure and low-pressure areas. It is the force of these waves pushing against tiny structures in your ears called stereocilia that enables you to hear.

Under the right conditions, this force can counteract the pull of gravity. It can hold small, lightweight objects in midair. An acoustic levitator bounces sound waves back and forth. It creates a standing wave, or a wave in which the high-pressure and low-pressure areas are fixed in space. The object stays nestled within a low-pressure area between high-pressure areas that hold it in place.

This isn't just a gimmick. Acoustic levitation has uses in manufacturing and in the laboratory. Substances that are too sensitive or too volatile to touch other materials can be suspended. But these sound waves can't be heard – they are ultrasonic, too high pitched for the ear to register. ⚠️



You can build an acoustic levitator just like this one. Here it is being used to levitate Styrofoam, water, coffee, and paper. (Images courtesy of Asier Marzo.)

## CAREER FIELDS

- Audio engineer
- Product designer
- Electrical construction

## Build an acoustic levitator with a 3-D printer!

With a 3-D printer and intermediate electronics skills, you can make an acoustic levitator thanks to engineers from the University of Bristol. The complete details, plans, and files can be found at [Instructables.com/id/Acoustic-Levitator](https://www.instructables.com/id/Acoustic-Levitator/).

Talk about a fantastic class project! If you take this on, be sure to let us know by emailing [cwhite@pitsco.com](mailto:cwhite@pitsco.com). ⚠️

# Cybercrime in 3-D

The bad guys are clever, so the good guys have to be cleverer to stay ahead of them. With the rise of 3-D printing, security experts worry about the ways nefarious hackers could turn this technology against us.

Critical parts in medical devices, space technology, infrastructure, and more are 3-D printed. A team of researchers at Rutgers University and Georgia Tech has carried out experiments showing it is possible to manipulate the printers to insert invisible flaws (such as tiny holes or fractures) into the objects

during the printing process. This follows the work of another team that demonstrated a drone crash caused by a defective 3-D printed propeller.

"The results could be devastating and you would have no way of tracing where the problem came from," said Assistant Professor Mehdi Javanmard of Rutgers.

The team identified a number of ways to guard against malicious attempts by hackers. The first and most obvious method is anti-hacking software. Another method involves using computers to monitor and analyze the sound of the printing process. The sound of the material being laid down in layers can indicate flaws. A third method involves inserting flecks of gold into the

material during the printing process. The printed object can be inspected later, and if the flecks have shifted, something is wrong with its structural integrity. ⚠️



## CAREER FIELDS

- Cybersecurity
- Law enforcement

# STEM FORCE

# HAUNTED HOUSE



Storyline: Cody White | Artwork: Jason Redd | ©2017 Pitsco Education

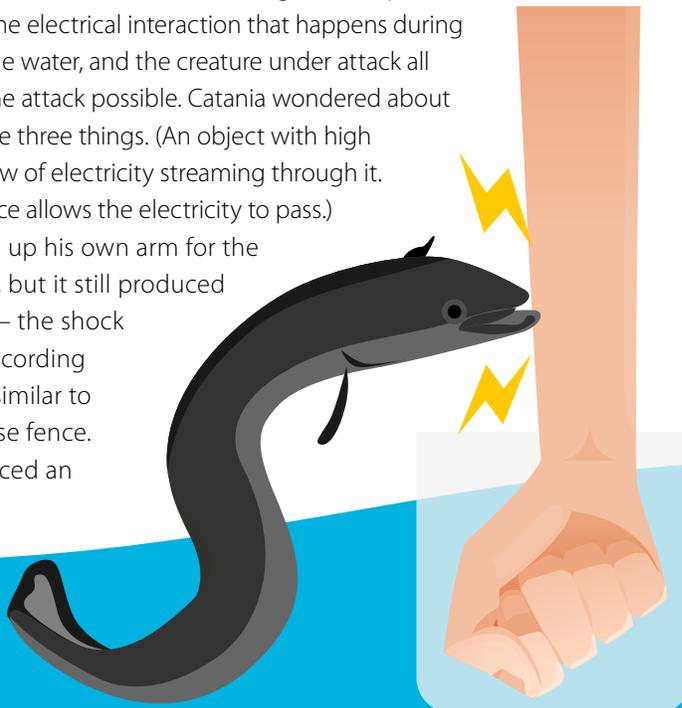
LEARN MORE ABOUT THE ELITE TEAM OF HEROES IN STEM FORCE BY VISITING [PITSCO.COM/SYSTEMALERT/STEMFORCE](http://PITSCO.COM/SYSTEMALERT/STEMFORCE).

## Electric eel attack

Sometimes working in the lab can be absolutely electrifying. Researcher Ken Catania from Vanderbilt University found this out when he stuck his arm in a tank with an electric eel. No slipup or mistake – Catania did this on purpose in the name of science.

Electric eels had interested him for some time. Previously he had investigated reports of the animals leaping out of rivers to attack horses. After showing this was possible, he turned his curiosity toward the electrical interaction that happens during an eel attack. The electric eel, the water, and the creature under attack all complete a circuit that makes the attack possible. Catania wondered about the electrical resistances of these three things. (An object with high electrical resistance halts the flow of electricity streaming through it. An object with high conductance allows the electricity to pass.)

To measure this, he offered up his own arm for the experiment. The eel was small, but it still produced quite a jolt. No bite necessary – the shock is delivered by touch alone. According to Catania, the sensation was similar to walking into an electrified horse fence. A larger eel would have produced an even larger shock. ⚠️



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Student name: \_\_\_\_\_ Class/Hour: \_\_\_\_\_

## **SySTEM Alert! Quiz (Volume 6, Number 2)**

1. This force must be resisted to levitate an object.
  - A. friction
  - B. gravity
  - C. electromagnetism
  - D. pressure waves
2. Acoustic levitation uses the power of \_\_\_\_\_.
  - A. sound waves
  - B. friction
  - C. conductance
  - D. opposing polarities
3. Sound happens when the \_\_\_\_\_ of an object causes surrounding air molecules to bump into one another.
  - A. electrical charge
  - B. vibration
  - C. ratio
  - D. conductance
4. This has been called the world's oldest computer.
  - A. the Antikythera device
  - B. Maglev II
  - C. OM/ONE
  - D. Lite-Brite
5. The \_\_\_\_\_ of an object affects every other object in the universe.
  - A. magnetism
  - B. electrical charge
  - C. gravity
  - D. vibration
6. Tiny structures in the ear called \_\_\_\_\_ enable hearing.
  - A. thoracic vertebra
  - B. patellas
  - C. stereocilia
  - D. cuticles



7. Bevel gears are normally positioned at a \_\_\_\_\_ angle to one another.
  - A. 35-degree
  - B. 75-degree
  - C. 90-degree
  - D. 120-degree
  
8. One method of detecting sabotage in 3-D printing involves inserting flecks of \_\_\_\_\_ in the product.
  - A. silver
  - B. nickel
  - C. titanium
  - D. gold
  
9. What is the most common type of gear?
  - A. worm gear
  - B. spur gear
  - C. bevel gear
  - D. rack and pinion
  
10. An object with high \_\_\_\_\_ halts the flow of electricity streaming through it.
  - A. electrical resistance
  - B. conductance
  - C. vibrational energy
  - D. gravitational force

**Bonus:**

Describe a technology that doesn't exist yet but that you believe will exist within the next 20 years. Are you looking forward to this technology? Why or why not?