

Solve for X:

Solve the Hoverboard Problem with Safety Standards

UL's team of researchers and engineers work with manufacturers to produce a safety standard for Electrical Systems for Personal Electronic Mobility Devices, which includes hoverboards.

The History

“What will the world be like in 100 years?” In the 1900s, this question was asked by the people attempting to predict the world we live in today. Many innovators imagined a world in which amazing inventions would transform **personal mobility**. Some of these creative thinkers took their visions toward the sky. This postcard illustrates what some people thought the world might look like in the 21st century.



This postcard was created by a German chocolate company in the year 1900. The artwork predicts how people would travel in the year 2000. What did the artist get wrong? What did the artist get right? What ideas do you have about how people will travel in the future?

This kind of forward thinking about transportation continued. In the year 1967, the word “**hoverboard**” was used for the first time by science-fiction author M.K. Joseph to describe a kind of hovering skateboard. The idea of hoverboards was made even more popular in 1989 by the movie *Back to the Future Part II*. In this movie, the character Marty McFly time travels from the year 1985 to the year 2015. In the movie’s futuristic version of 2015, Marty rides a skateboard that can **levitate** above the ground.

Today, the name “hoverboard” usually means a type of self-balancing scooter.



These hoverboards may not be the levitating skateboards that people imagined in the 20th century, but they are still an invention that changed the way that people get around.

When hoverboards were first sold in the United States, they quickly became popular. But these devices had a dangerous secret, which remained unknown until – for some homes and families – it was too late. The hoverboards were starting fires and in some cases, explosions.

Soon, the best and brightest minds at Underwriters Laboratories (UL) were on the case. They needed to convene a group of experts to develop a new safety standard for hoverboards, and they had to do it quickly.

Discussion Questions:

- A. **Personal mobility** means the way that we move around as individuals. People move around on foot, by bicycle, by wheelchair, by scooter, and by car, for example. What methods of personal mobility do you commonly use? Do you use different kinds of personal mobility to get to different kinds of places?
- B. Imagine a new kind of personal mobility that is used by people 100 years in the future. What does it look like? Who uses it? Where do they go?
- C. In the 20th century, creative thinkers predicted the way that we move would be dramatically changed by whimsical inventions. What did these predictions get right? What did they get wrong?

The Problem

By the end of 2015, it was clear that there were dangerous risks associated with hoverboards. The most serious of these issues came from the batteries that powered the devices.

Hoverboards are powered by **lithium-ion batteries**. Lithium-ion batteries are rechargeable. They can store a lot of energy in a very small battery, and they can transfer that energy quickly. However, they are also somewhat fragile. Damaging a lithium-ion battery in certain ways can trigger a process called **thermal runaway** in the battery. Thermal runaway is a rapid, uncontrolled increase in temperature that causes further increases in temperature. It can result in fire or an explosion.

The lithium-ion batteries that were used in early hoverboards overheated and caught on fire. Sometimes they caught on fire after they were fully charged. Sometimes they caught on fire while someone was riding the hoverboard.

In some cases, the lithium-ion batteries were on certain hoverboards not being tested. They were being made quickly to keep up with **consumer demand** for hoverboards. These quickly-made batteries were especially prone to thermal runaway.

In December 2015 and January 2016, the **U.S. Consumer Product Safety Commission (CPSC)** warned the public that there were no safety standards for these self-balancing scooters. This meant that there were no set of guidelines, rules, or tests to verify that the hoverboards were safe to use.

Safety problems persisted. In February 2016, the CPSC declared that no hoverboards could be considered safe for use. In July 2016, the CPSC **recalled** about half a million hoverboards. By 2017, the CPSC reported that it was aware of more than 250 cases of fires or explosions and \$4 million in property damage due to hoverboards.

Discussion Questions:

- A. In your own words, summarize the problem and why it was happening.
- B. The three “Why’s”:
 - Why does this problem matter to you?
 - Why does it matter to the people around you? (your family, friends, neighbors, classmates, etc.)
 - Why does it matter to the world?
- C. From your own experience:
 - Have you ever faced a similar safety issue, with a hoverboard or another device? Or, have you ever heard of anything similar to this happening to someone else?
 - Did you hear about this in the news while this problem was happening?

The Result

Here is a list of some of the steps that were taken in order to resolve the hoverboard safety problem:

- In November 2015, UL was alerted to the issue of hoverboard fires.
- Before a Standard was created, many stores stopped selling hoverboards. They were banned from many airplanes, buses, and trains to avoid the risk of fire in an enclosed space.
- In March 2016, Underwriters Laboratories convened the first **Standards Technical Panel (STP)** meeting for the hoverboard Standard. At this meeting, the different members of the Panel weighed in and explained what they thought should be included in the standard.
- In November 2016, The Standard for Safety for Electrical Systems for Personal E-Mobility Devices, UL 2272 was approved by the STP and published.
- In 2017, China published a standard for hoverboard safety requirements and testing methods that was based on UL 2272. Because of this, the hoverboard safety requirements were similar between the American and Chinese standards, but they were not exactly the same.
- In June 2018, UL and the Standardization Administration of China signed an agreement. They agreed to work together to create shared requirements for hoverboards.

There are many different types of tests and requirements outlined in UL 2272. Examples of these tests include:

- The [Blunted Nail test](#)
- The [Fire Exposure and Projectile test](#)
- The [Crush test](#)
- The [Abusive Overcharge test](#)

The ways that the batteries were damaged during tests were based on the ways that the batteries were damaged inside of a hoverboard (for example, being dropped). Each of these tests and more can be explored in [UL Xplorlabs: Portable Electrical Power](#).

UL 2272 explains the requirements for each of these tests: how the tests must be done, and what results mean the device is safe to use. When a hoverboard passes all of the tests, it receives a certification saying that it meets the requirements. Once this Standard was published, people could start buying and using hoverboards again.

Discussion Questions:

- A. Why do you think hoverboards were once again allowed to be sold only after a safety standard was developed?

Developing A Standard

In its simplest form, a **standard** is a level of quality or **attainment**. At UL, our Standards are **consensus-based documents** (or written agreements) which guide the safety, performance and **sustainability** of products, processes or systems.

Think of a “standard” as the learning goals that are laid out for what students must be able to do at each grade level. For instance, in kindergarten, a standard in math is that a student must be able to count to 100 both forward and back. A life science standard for middle school is that a student can describe the function of and identify the parts of a cell.

UL Standards are **consensus-based standards**. What does that mean? Let’s go back to the example of the science class. If doctors were to write a standard for science education, they may have a different idea of what a middle school student would need to know in order to receive a “B” or an “A” on the science test. If teachers were to write the standard, they may have another idea of what a middle school student should know. The standard is improved when a teacher and a doctor and other experts create it together because they share their expertise with each other. They may not agree on everything, so voting takes place to determine the group’s consensus for what should be in the standard.

It takes a team of experts to create a safety standard. There are thousands of safety standards, and different groups of experts for each standard. In a consensus-based standard, those different groups work together to determine the tests and levels of what will be safe. In this way, no one group’s opinion or preference overrides the others. The requirements in a UL Standard have been agreed upon in by experts from different interest groups comprised to makeup the Standards Technical Panel (STP).

Showing your work on the test helps your teacher see that you understand the material to a certain level. Your teacher wants to make sure that you understand everything that you’ve learned in class so far. For example, after learning about the human body in science class, you might have a science test. On this test, you write about how human systems work in your own words to show your teacher that you understand the material. Then, your teacher gives you a grade like an “A” or a “B” depending on how much you show that you understand.

Similarly, in order for a **manufacturer** to show that their products follow a standard for safety, they need to demonstrate that the product can pass certain tests.

UL 2272 lists the ways that hoverboards must be tested and other important requirements. There are specific results to these tests that help to determine whether the hoverboard is safe to use. Other test results may show that the hoverboard needs to be redesigned. The Standard explains each of these results. If the hoverboard passes all of these tests, it can receive a certification if the tests were performed by an independent, accredited testing company. The certification helps assure consumers that the device has been tested and meets the requirements in the Standard.

Discussion Questions:

- A. Why do you think safety standards are important? How could a safety standard help solve the problems that we saw with early hoverboards?
- B. Do you think we should have safety standards for all products? Why or why not?
- C. Can you think of other examples where we use standards?

Classroom Activity

You and a group of your classmates will join together to form a Standards Technical Panel. Each panel will consist of 4 students. Your panel’s responsibility is to establish a new standard for an electronic device that is not a hoverboard.

Standards are not just used to evaluate hoverboards. There are different standards for many kinds of products. For example, there are Standards for chargers, power banks, and e-bikes. Why might a standard be useful for each of these products?

1. On your own, think of at least two other products that might present a risk to people who are using them. What is the risk? Then, within your group, discuss the products you have each identified. As a group, decide on one product for which to create a new standard.
2. With your group, discuss the reasons why UL 2272 (the Standard for hoverboards) was created. Why did hoverboards present a risk to people using the product before the Standard was developed? What did the Standard achieve? Consider these factors when creating your Standard as a group. Discuss the risks associated with your product. Also discuss the goal of the new Standard your group will create.
3. Next, identify at least 1 to 3 tests that will ensure that your chosen product is safe to use. You should not conduct these tests yourselves. Standards tests are done by professionals in a safe laboratory setting. For examples of these tests, you can visit UL Xplorlabs: Portable Electrical Power. The tests in this module are some of the tests that were conducted for UL 2272.
4. Your group will describe the tests that may be necessary for your device. Explain what each test will show. Write instructions for how the tests would be conducted. are important and how the tests would be conducted. What result would be necessary to prove that your device is safe to use?
5. Finally, as a group, your Standards Technical Panel will present the standard to the rest of the class. Your group will introduce the product, describe the risk you identified, and describe the tests that you developed for your product.
6. In addition to your presentation, your group will also turn in a written standard. All standards must include:
 - The name of the Standard (for example, “UL 2272: Certification for Next Generation Personal e-Mobility”)
 - The names of everyone in the Standards Panel (you and your team members)
 - The device chosen by your Standards Panel
 - The safety issues that you found related to the device
 - The goal of your new Standard
 - The steps that should be taken in order to solve the safety problem:
 - Describe each necessary test (at least 3)
 - Describe the test result that will prove the device is safe to use (a result for each test)
 - Explain why each test is important – what does the result show?

Additional Learning

Now that we have learned about UL Standards and hoverboards, why not have some creative fun? You saw what the people of the early 1900s thought the world would look like today. What do you think the world will look like in 100 years? As a team or on your own, make a drawing of your idea, then share it with your class!

Glossary

Personal mobility device: A device that helps people by assisting with individual transportation, such as a wheelchair, scooter, skateboard, bicycle, and a hoverboard. Personal mobility devices can be used for recreation or transportation.

Manufacturer: A person, company, or business that manufactures (produces) a product.

Consensus: A collected opinion reached by a group of people. When everyone in the group reaches the same opinion or agrees on an opinion.

Standard: A level of quality or safety that manufacturers are expected to achieve, and consumers expect to receive.

Hoverboard: A two-wheeled, electric personal mobility device that is popular around the world.

U.S. Consumer Product Safety Commission (CPSC): An agency of the United States government that promotes product safety, helps with the creation of standards, and conducts research to test if products cause illness or injury.

Levitate: To rise in the air, or to float.

Consumer demand: When large quantities of people purchase a particular product and manufacturers try to make more of their product for all the people who want it.

Recall: To cancel or take back. When a product is recalled, the manufacturer of that product may be required to get their product back from the consumer, inform the consumer that the product is not safe, or fix or replace the product at no charge to the customer.

Attainment: An accomplishment or achievement.

Consensus-based standards: Standards that are created when a group of experts, manufacturers, and product users come to an understanding and agreement.

Sustainability: A measure of environmental and social responsibility.

Standards Technical Panel: A meeting of experts (scientists, engineers, etc.) who come together to create or develop a standard.

Lithium-ion battery: A type of battery that is powered by the movement of lithium ions between electrodes.

Thermal runaway: A rapid, uncontrolled increase in temperature causing additional increases in temperature, usually resulting in a hazardous situation.