

# Last Day on Mars Educators Guide

## ABOUT THE BOOK

It is Earth Year 2213—but, of course, there is no Earth anymore. Not since it was burned to a cinder by the sun, which has mysteriously begun the process of going supernova far sooner than anyone expected.

The human race has fled to Mars, but this was only a temporary solution while preparing for a second trip: a 150-year journey to Aaru-5, a distant star, humanity's best guess at a good spot for a new home.

Liam Saunders-Chang is one of the last humans left on Mars. The son of two scientists who have been racing against time to create technology to ensure humanity's survival, Liam, along with his friend Phoebe, will be on the last starliner to depart before Mars, like Earth before it, is destroyed.

Or so he thinks. Because before the last day on Mars is over, Liam and Phoebe will make a series of profound discoveries about the nature of time and space and find

out that the human race is just one of many in the universe locked in a dangerous struggle for survival.

Kevin Emerson has written the first book in an ambitious space epic—a powerful, emotional, pulse-pounding story of the final days of humanity's first home beyond Earth, and the desperate search for another.



## FACT AND FANTASY IN *LAST DAY ON MARS*

By Kevin Emerson

I'm a big fan of science fiction and fantasy. How big? I can't make fish sticks without calling them fish fingers and custard, I refer to the night sky as "the black," and I always make time for second breakfast (well, technically more like elevensies). I was also a K-8 science teacher for many years, and a biology major in college. So, I love writing stories that blend both real science concepts and fantasy elements.



In *Last Day on Mars*, I got to explore so many cool ideas! While many parts of the book are pretty obviously science fiction, there are a number of interesting science concepts at work. In this guide you will find out about some aspects of Mars I was playing with when writing the book—along with some STEM activities that illustrate my points.



### ABOUT THE AUTHOR

*Kevin Emerson is the author of The Fellowship for Alien Detection as well as the Exile series, the Atlanteans series, the Oliver Nocturne series, and Carlos is Gonna Get It. He is also an acclaimed musician who has recorded songs for both children and adults. A former K-8 science teacher, Kevin lives with his family in Seattle. Visit him online at:*

<http://www.kevinemerson.net>

## THE STEM BEHIND THE STORY

### WHAT IS MARS LIKE?

Mars is a cold desert, with an average overall temperature of about  $-67^{\circ}$  (F). It is about half the size of Earth. Just as Earth is called the Blue Planet because about 70% of its surface is covered with water, Mars is called the Red Planet because the surface of the ground is covered with rusty, red iron. Mars has seasons, polar ice caps, volcanoes, canyons and weather.

Though there are signs of ancient floods on Mars, water there now mostly exists in icy dirt and thin clouds. There is also some evidence of liquid salt water in the ground.

### HOW DO THE ATMOSPHERES ON MARS AND EARTH COMPARE?

Mars, like Earth, has an atmosphere, but the chemical compositions of these atmospheres are very different.

Earth's atmosphere is 78% nitrogen, 21% oxygen and 0.03% carbon dioxide (plus other miscellaneous gases). The atmosphere on Mars is very thin compared to Earth and made up differently: 96% carbon dioxide, 1.9% argon, 1.9% nitrogen and traces of water and other chemicals. Note the lack of oxygen, the element humans need most!

### COULD HUMANS LIVE ON MARS?

It would require a lot of special equipment and adaptations.

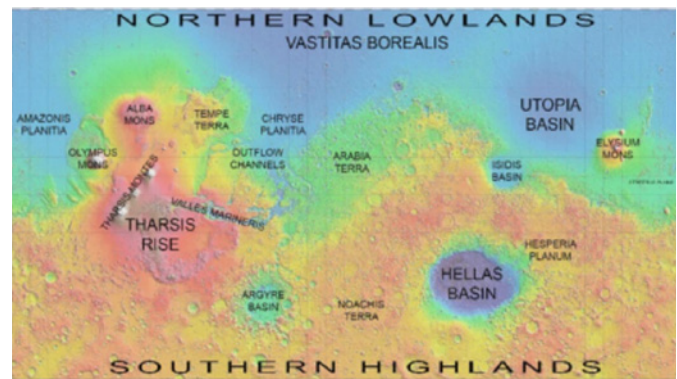
Check out this animated film by Mari Foroutan. It describes many of the adaptations that Liam, Phoebe and all the other humans would have had to make to stay alive during their time on Mars:

<https://youtu.be/DMMPYkRrd4o>

### WHERE IS THE COLONY IN THE BOOK?

The colony where Phoebe and Liam live is located on the Amazonis Planitia, to the west of Olympus Mons, a real life, enormous (though extinct) volcano.

Can you locate Phoebe and Liam's colony on the map below?



### DID YOU KNOW...

That Mars has two moons, Phobos and Deimos? They are tiny—Phobos is only 14 miles across and Deimos is only 8 miles across. Phobos travels around Mars three times a day, moving across the skyline about once every four hours, traveling from west to east. Deimos takes 30 hours, a little over a Martian day, to travel around the Red Planet. Interestingly, the two moons' orbits are opposite each other: Phobos rises in the west and sets in the east while Deimos does the opposite.

### FOR MORE ON MARS, VISIT:

<http://mars.nasa.gov/>

[https://www.nasa.gov/mission\\_pages/mars/main/index.html](https://www.nasa.gov/mission_pages/mars/main/index.html)

<http://www.space.com/47-mars-the-red-planet-fourth-planet-from-the-sun.html>

<http://www.exploratorium.edu/mars/index.php>

## MORE STEM BEHIND THE STORY

### MARS FACTS

Mars has the largest dust storms in the solar system. They can last for months and cover the entire planet.

On Mars the Sun appears about half the size as it does on Earth.

At the closest point to the Sun, the Martian southern hemisphere leans towards the Sun, causing a short, intensely hot summer, while the northern hemisphere endures a brief, cold winter: at its farthest point from the Sun, the Martian northern hemisphere leans towards the Sun, causing a long, mild summer, while the southern hemisphere endures a lengthy, cold winter.

Pieces of Mars have fallen to Earth. Scientists have found tiny traces of Martian atmosphere within meteorites violently ejected from Mars, then orbiting the solar system amid galactic debris for millions of years, before crash landing on Earth. These pieces of Mars allowed scientists to begin studying Mars before launching space missions.

Mars takes its name from the Roman god of war. The ancient Greeks called the planet Ares, after their god of war; the Romans then did likewise, associating the planet's blood-red color with Mars, their own god of war. Interestingly, other ancient cultures also focused on color—to China's astronomers it was 'the fire star', while Egyptian priests called on 'Her Desher', or 'the red one'.

(This and more at: <http://space-facts.com/mars/>)

### YOUR WEIGHT ON MARS

The gravity on the surface of Mars is 38% of the gravity on Earth. A person who weighs 100 pounds on Earth would weigh 38 pounds on Mars. That may be the reason for the skip in Liam's step (see below) when the artificial gravity failed! What is your weight on Mars? (*Hint*: multiply your weight by .38)

#### **From *Last Day on Mars*:**

"Liam felt a subtle lightening as the artificial gravity failed. Mars's native gravity was only about one-third as strong as Earth's, so all the colony floors and streets were wired to make a magnetic field that brought the gravity up to Earth level. Everyone wore specially lined clothing and boots that reacted with the field: standard-issue black shirts and pants that had been handed down at least three times and, by this point, were made of more patches than original fabric. Most of the soft lining was gone from the insides of Liam's boots, and they were too tight and giving him blisters. But Liam actually preferred when the gravity system failed. Earth's gravity made him feel like he was covered in heavy blankets all the time. Whenever he was out at the research station, which didn't have artificial gravity, he could jump farther and climb more easily, like a stronger, faster version of himself. His parents complained that Martian gravity gave them headaches and joint pain, but Liam and Shawn never felt that way, maybe because they'd been born here. It didn't seem to bother any of the other kids in the colony, either." (Pages 27-28)



## STILL MORE STEM BEHIND THE STORY

### TEMPERATURE AND ATMOSPHERIC PRESSURE ON MARS

In *Last Day on Mars*, humans live inside a dome that simulates conditions on Earth. Whenever they step outside the dome, they wear spacesuits that also simulate these conditions. They have to. It's cold on Mars, with an average temperature of  $-67^{\circ}$  Fahrenheit (although it may get up to almost room temperature at the Mars equator, on the hottest summer day). Also, the atmospheric pressure on Mars is very different from on Earth, which would cause further dire consequences for an unprotected human.

The pressure of the atmosphere that surrounds Earth is 14.7 pounds per square inch (PSI). The air pressure on Mars is 0.087 PSI. That's only 0.6% of the atmospheric pressure on Earth, or equivalent to the atmospheric pressure about 21 miles above Earth's surface. This difference in air pressure between Earth and Mars has many effects. For example, the lower air pressure on Mars causes water to boil at a much lower temperature than on Earth.

What might this mean to a human on Mars, especially a very unlucky human who ended up on the surface of Mars without a pressurized space suit? Besides the fact that the human could not breathe in the Martian atmosphere (remember, no oxygen!), the change in pressure would mean that in less than thirty seconds, the fluids in that person's body would evaporate, oxygen would leave her tissues, her circulation would fail, she would be unable to move, and her lungs would collapse (while continuing to release water vapor, leading to rapid cooling and ice formation in her respiratory system). There is a small possibility that she would survive, if she were rescued and recompressed within 90 seconds. But the odds would be against it.

### HOW LONG IS A YEAR ON MARS?

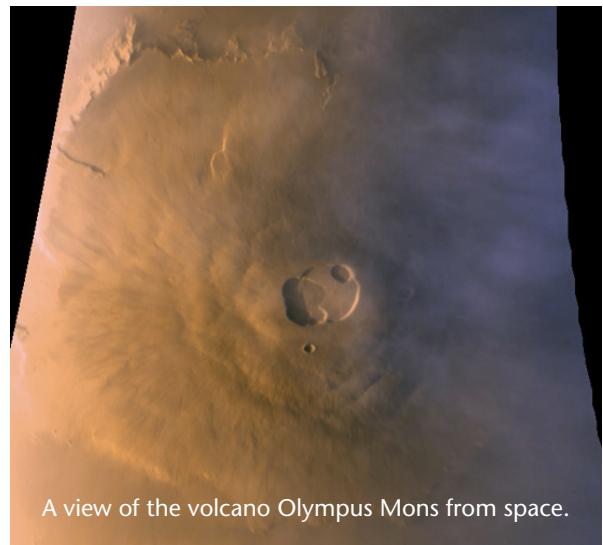
A day on any planet is the time it takes for that planet to rotate once on its axis relative to the sun. Our home planet Earth rotates once every 24 hours. A day on Mars is called a sol. In Earth terms, a sol is 24 hours, 39 minutes and 35 seconds long. Though the length of a day is pretty similar on both planets, the length of a year is not. Because Mars is (on average) about 50 million miles farther from the sun than Earth is, it has a longer year. A year on Earth is approximately 365 days long. A Martian year is 687 Earth Days long.

How old would you be on Mars? To find out, go here:

<http://www.exploratorium.edu/mars/yourage.php>

#### **From *Last Day on Mars*:**

"Eighteen halfhearted hands raised from the back of the room. The last Year 10 students, thirteen Earth years old—or, if you wanted to annoy your parents, you could say you were almost seven in Martian years." (Page 22)



A view of the volcano Olympus Mons from space.

## CREATIVE ACTIVITIES

### VISIONS OF THE FUTURE

Liam and his family and everyone else on Mars are heading to a new home in another galaxy where nobody has ever been. They really don't know what it will be like. How would you feel if you were in that situation?

**IMAGINE...** Pretend you are joining Liam on the journey to Aaru-5. Imagine what it would be like to be there. For inspiration, look at the Visions of the Future posters at:

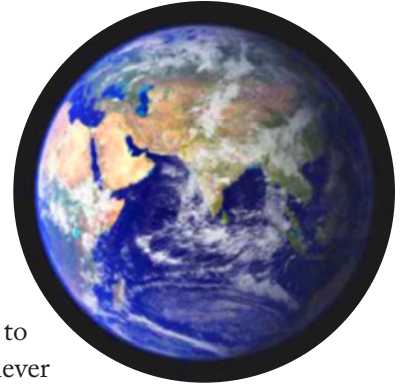
<http://www.jpl.nasa.gov/visions-of-the-future/>

Make a poster, or create an advertisement, brochure, or travel article about humanity's new home.



### OUR LEGACY

**IMAGINE...** Liam's parents and the other adults in the colony remember Earth fondly. They built an Earth Preserve, full of plants and exhibits, for their own comfort and to educate the kids who never knew Earth. Even so, Earth means little to the kids who have grown up on Mars.



#### From *Last Day on Mars*:

"Grown-ups never called Mars 'home.' Earth was *home*, humanity's home, the ol' green and blue. Liam had sat through hours of class time learning about its oceans and cities, about the wars, its pyramids, and its first missions to its moon.... All of it was interesting, but only to a point." (Page 41)

Think about everything you cherish on our little blue planet. If you were settling on a new planet, what would you want people who came after you to know about? What would be in your exhibits? What plants? What historical events? What parts of humanity's culture?

## MORE CREATIVE ACTIVITIES

### MARTIAN-HUMAN IDENTITY

**IMAGINE...** Most of the adults in the Martian colony retain a memory of their national or ethnic identity from their time on Earth, even though that planet is destroyed. Not the kids, and especially not Liam, who considers himself a Martian-human, plain and simple.

#### From *LAST DAY ON MARS*:

“Ms. Avi said it hadn’t been easy unifying all of Earth’s cultures and histories under one common flag. There had been wars, standoffs, lines in the Earth sand. For a while, the North American Federation was going to build its own starliner, the Chinese Empire their own, and so on, but ultimately, time had been so short that everyone had to work together. Those Earth identities still mattered to some people, especially the older generations. Liam’s grandmother, who had left two years ago on the Starliner Osiris, had listed off Liam’s ethnicities and nationalities one time: Thai, Irish, Nigerian, Texan, and like ten more that he couldn’t remember. To Liam, they were just words for bits of land on a planet he’d never known. He was fine being one thing.” (Page 40)

Consider your own ethnic and/or cultural identity. If you were in the position of Liam’s parents and grandparents, would you want to make sure to pass along awareness of your identity?

Write a personal poem, essay or other creative piece about what passing along your identity would mean to you.

### LEAVING HOME

**IMAGINE...** Liam is very sentimental as he gets ready to leave—visiting favorite spots for the last time, afraid of what lies ahead. And he is only allowed to take one small box with him, and only his very favorite things. If you were leaving your home behind forever, like Liam, what would you miss? What would you put in your small box? Draw, paint, photograph, write, or otherwise create something to represent what you would miss and what you would take with you.

#### From *LAST DAY ON MARS*:

“It seemed like all anyone wanted to do was get out of here. Sometimes Liam felt like he was the only one who was sad to be leaving Mars, and so it must be a stupid way to feel, and yet he felt it anyway.” (Page 42)

