The Lius board the maglev, and it starts to move. It starts slowly, but then it picks up speed. The maglev can reach speeds of up to 268 mi. per hour (431 km per hour). That means it will only take them 8 minutes to get from the airport to Longyang. If they drove, it would take them about 20 minutes. Sheng asks his dad how the train travels so fast. His dad says that there are strong magnets on the bottom of the train and in the track. When electricity passes through the track, the force is even stronger than gravity. It pushes the train away from the metal. The maglev floats in the air above its track!

Lin learned about **electromagnetism** in school. Her teacher told the class to wrap a wire around a nail. Then, they touched each end of the wire to the ends of a battery. Lin was able to use the nail to pick up a paper clip! This is similar to how the maglev works.

## LET'S EXPLORE MATH

Lin's class worked in teams to build miniversions of electromagnets. First, teams had to wrap wires around nails 40 times. Lin said, "If each of us wraps the wire 8 times, we will be finished!"

1. How many students were on Lin's team? Complete the equation:

   ___ students × 8 wire wraps each = 40 wire wraps

2. There were 6 teams of students in Lin's class. Each team built an electromagnet. How many total times did the class wrap their wires?

Lin and Sheng look out the window of the maglev. They watch the city zoom by. They can see the Shanghai Tower in the distance. It is the tallest building in China. The swirling tower stands tall at 2,073 ft. (632 m) tall. That is more than eight airplanes stacked nose to tail!

They can also see the Oriental Pearl Radio & TV Tower. Lin thinks it looks like a rocket ship. She sees a sign on the maglev for a **revolving** restaurant at the tower. It is about halfway up the tower. Sheng wants to stand on the glass floor of one of the observation decks. He wants to look straight down to see the ground far below!

They arrive at Longyang Road Station in what seems like no time at all. Lin, Sheng, and their parents step off the train. They are ready to explore the sights and sounds of Shanghai!

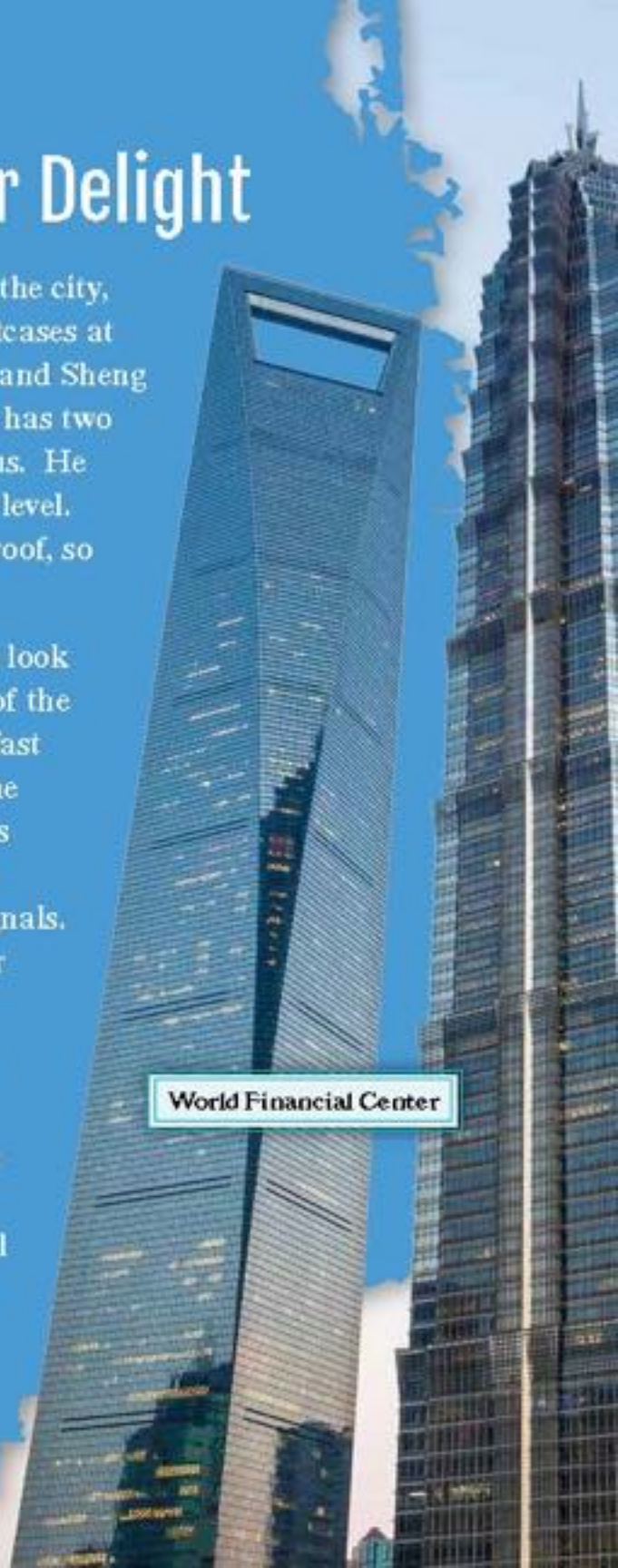

Longyang Road Station

# Double-Decker Delight

Before the Lius can explore the city, they need to drop off their suitcases at the hotel. They hop on a bus, and Sheng looks around in awe. The bus has two levels! It is a double-decker bus. He and Lin want to sit on the top level. The top level does not have a roof, so there is a lot to see!

As they ride, Sheng and Lin look to the left and right to see all of the sights. The bus ride is not as fast as the maglev. Traveling on the busy city streets means the bus must make a lot of stops. The driver needs to obey traffic signals. And, he needs to watch out for **pedestrians**.

The bus brings them to the Shanghai World Financial Center. It is the second-tallest building in the city. It has offices, shops, and even a hotel on the 79th floor! Lin cannot believe they are staying here!



The blurred image tells you that this ride is moving fast!

## Carousels

Carousels are not as exciting as other rides at the amusement park. But they rely on the laws of motion, too. It may seem simple, but all the horses on a carousel must move through one complete circle in the same amount of time.

# Fastest Roller Coasters*

| Rank | Roller Coaster | Speed | Location |
|---|---|---|---|
| 1. | Ring Racer | 217 kph/135 mph | Nürburgring, Rhineland-Palatinate, Germany |
| 2. | Kingda Ka | 206 kph/128 mph | Six Flags Great Adventure, New Jersey, U.S.A. |
| 3. | Top Thrill Dragster | 193 kph/120 mph | Cedar Point, Ohio, U.S.A. |
| 4. | Dodonpa | 172 kph/107 mph | Fuji-Q Highland, Yamanashi, Japan |
| 5. (tie) | Superman: The Escape | 161 kph/100 mph | Six Flags Magic Mountain, California, U.S.A. |
| 5. (tie) | Tower of Terror | 161 kph/100 mph | Dreamworld, Queensland, Australia |

* According to Roller Coaster Database

# Velocity and Acceleration

Another way to measure motion is called **velocity** (vuh-LOS-uh-tee). This is how an object's position changes over time. Velocity is a change in speed and direction. Think about jogging in place. You might be moving your legs very fast. But in the end your place has not changed. So, that would be zero velocity.

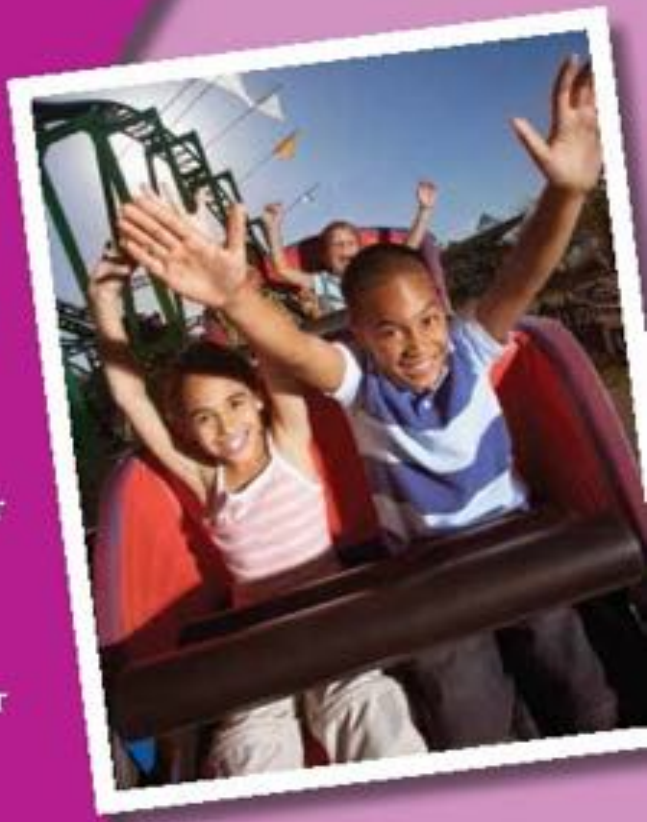
Another measurement is **acceleration** (ak-sel-uh-RAY-shuhn). Many people think acceleration means moving fast. But a person can be moving fast and still not accelerate. An object accelerates if it changes speed. If a ride begins to move forward, that is acceleration. When it slows down, it is negative acceleration. That is called **deceleration** (dee-sel-uh-REY-shuhn).

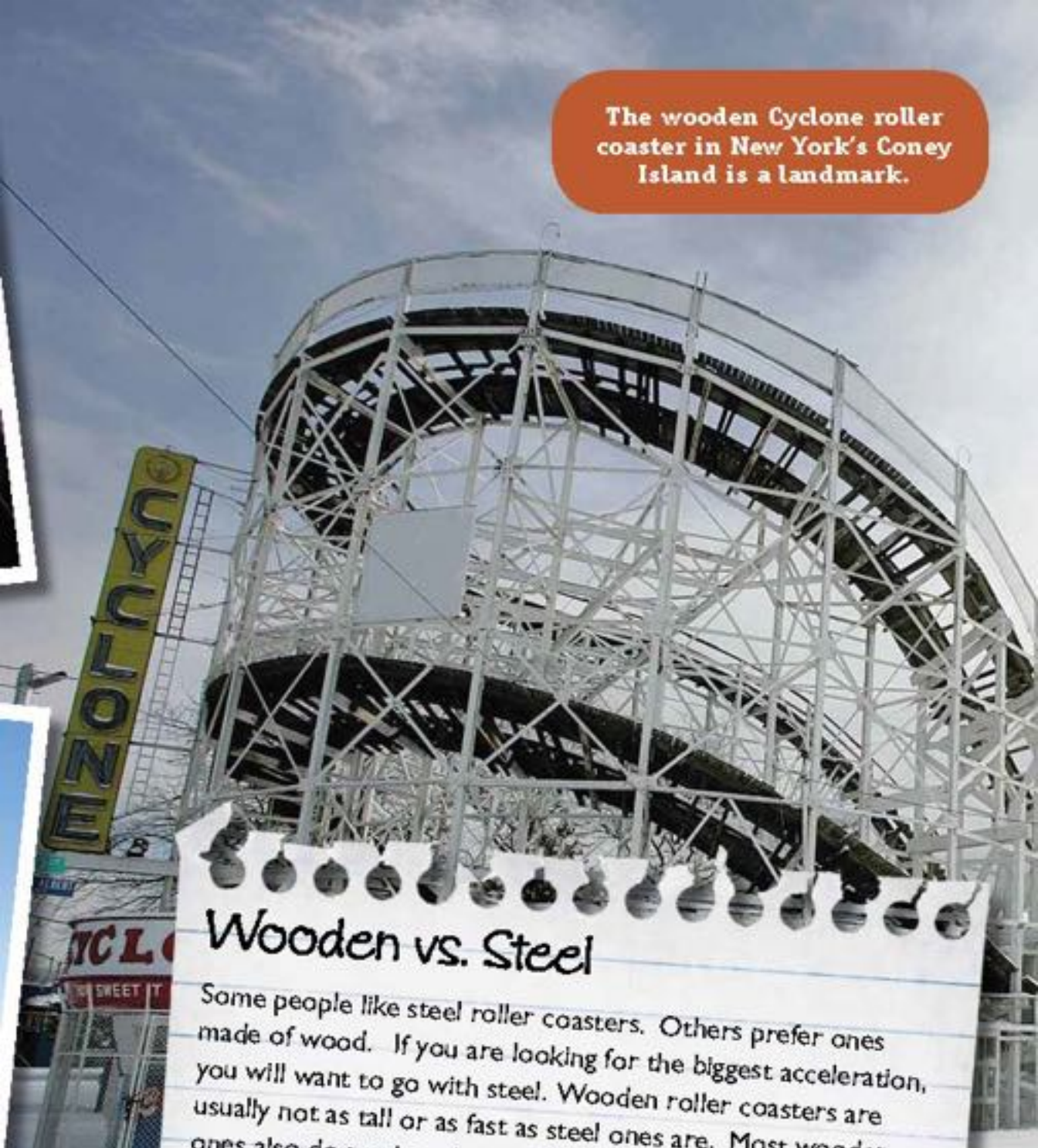
**Kingda Ka at Six Flags is 139 meters (456 feet) high!**

# Thrills and Chills

Some people travel all over the world to visit amusement parks. They wait hours in line for short rides. Why do they do it? For many people, it is all about the roller coaster. There is good reason why some people call it the "scream machine." The people who design roller coasters are always looking for ways to add more thrills and chills.

What makes one roller coaster more exciting than another? Some people would say that it is how steep the drops are. Other people would say it is the speed. But most roller coasters do not go much faster than cars on the freeway. Acceleration is what makes it feel so fast. Some new roller coasters can reach top speeds in just two seconds!





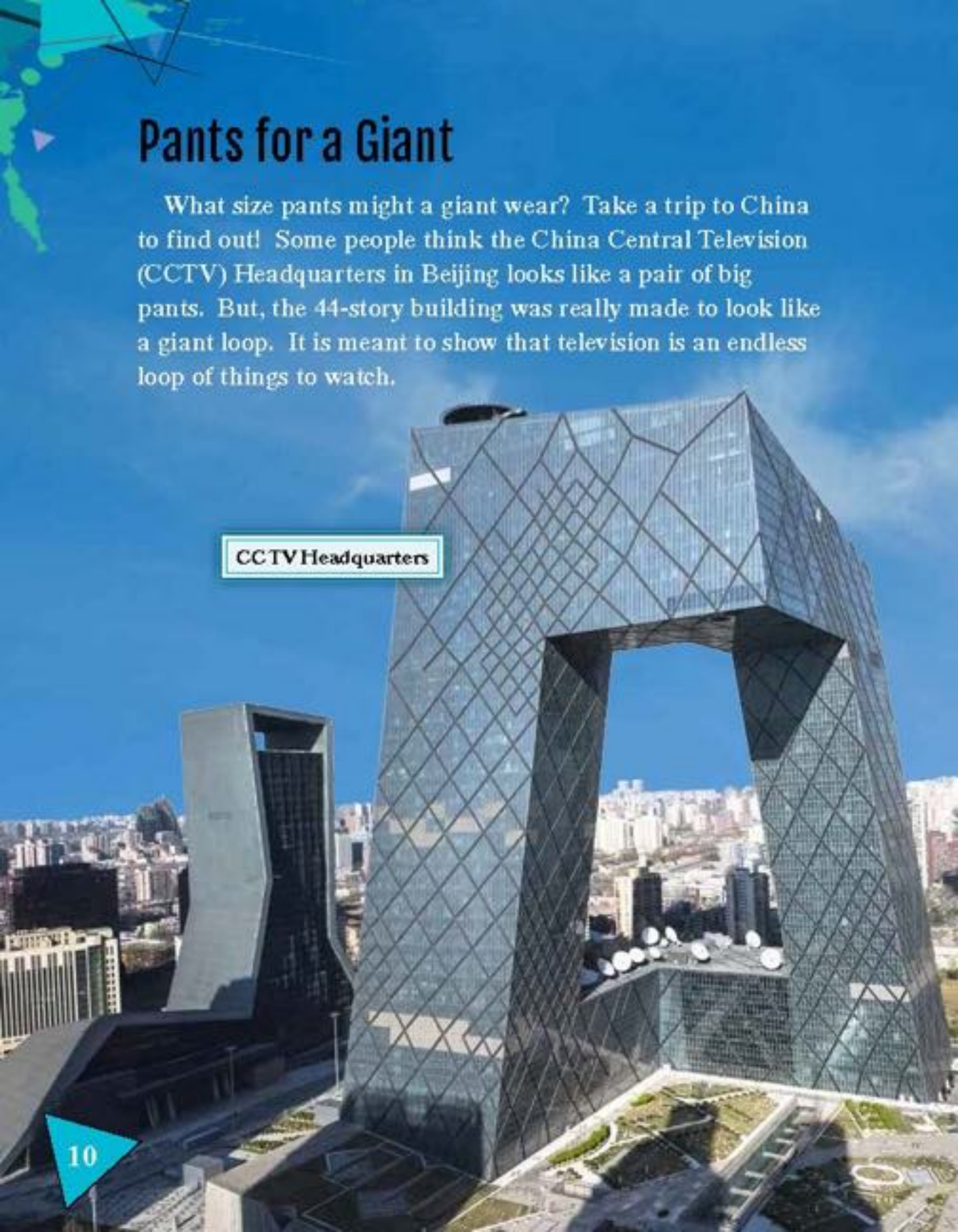

The wooden Cyclone roller coaster in New York's Coney Island is a landmark.

## Wooden vs. Steel

Some people like steel roller coasters. Others prefer ones made of wood. If you are looking for the biggest acceleration, you will want to go with steel. Wooden roller coasters are usually not as tall or as fast as steel ones are. Most wooden ones also do not have loops. So why do so many thrill seekers love wooden coasters? It is because the wood makes the coaster sway a lot more. Now *that's* scary!

# Pants for a Giant

What size pants might a giant wear? Take a trip to China to find out! Some people think the China Central Television (CCTV) Headquarters in Beijing looks like a pair of big pants. But, the 44-story building was really made to look like a giant loop. It is meant to show that television is an endless loop of things to watch.



CCTV Headquarters

Since the building is in a **seismic** zone, it had to be built with earthquakes in mind. The finished building now has six sections. Visitors can make the trek up to a viewing deck. Once there, they can look out at the skyline. The bravest visitors look through three round glass plates in the floor straight down to the ground! Would you be brave enough to do the same?

## LET'S EXPLORE MATH

Imagine that a wall of TVs is going to be installed for visitors in the lobby of CCTV Headquarters. There are 50 TVs. Each TV is a square, measuring 1 meter on each side. The wall is 5 meters tall and 10 meters wide.

1. What are three ways you can find the area of the wall? Will they all give you the same answer? Which is the most efficient way?
2. Will all 50 TVs fit on the wall? Will there be room for more?

# Robot on the River

Thailand is a country made up of small towns. In fact, Bangkok is its only big city. Bangkok is known for its ancient palaces and temples. But these sit among new technology.

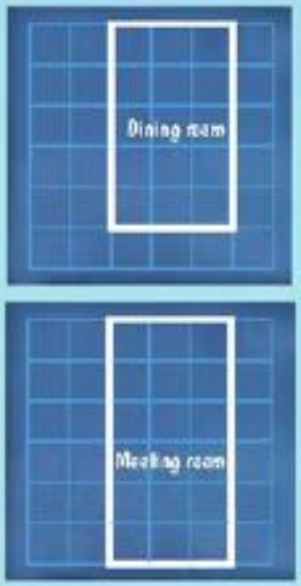
On the banks of the Chao Phraya (JOW PRY-uh) River stands a huge robot! How did it get there? One day, **architect** Sumet Jumsai saw his son's robot toy. Just like that, he was inspired, and an idea was born! That idea became this 20-story structure. This kind-looking robot reminds people that the bank it houses is modern and uses technology.

The Robot Building is fun to look at. But its parts also serve a purpose. The eyes are windows. The eyelids keep the sun out. The antennas are lightning rods. At night, the robot comes to life! Well…sort of. The eyes entertain people by "winking" along to music.

the Robot Building

## LET'S EXPLORE MATH

Behind the "eyes" of the robot are a dining room and a meeting room. Imagine that these are their floor plans.



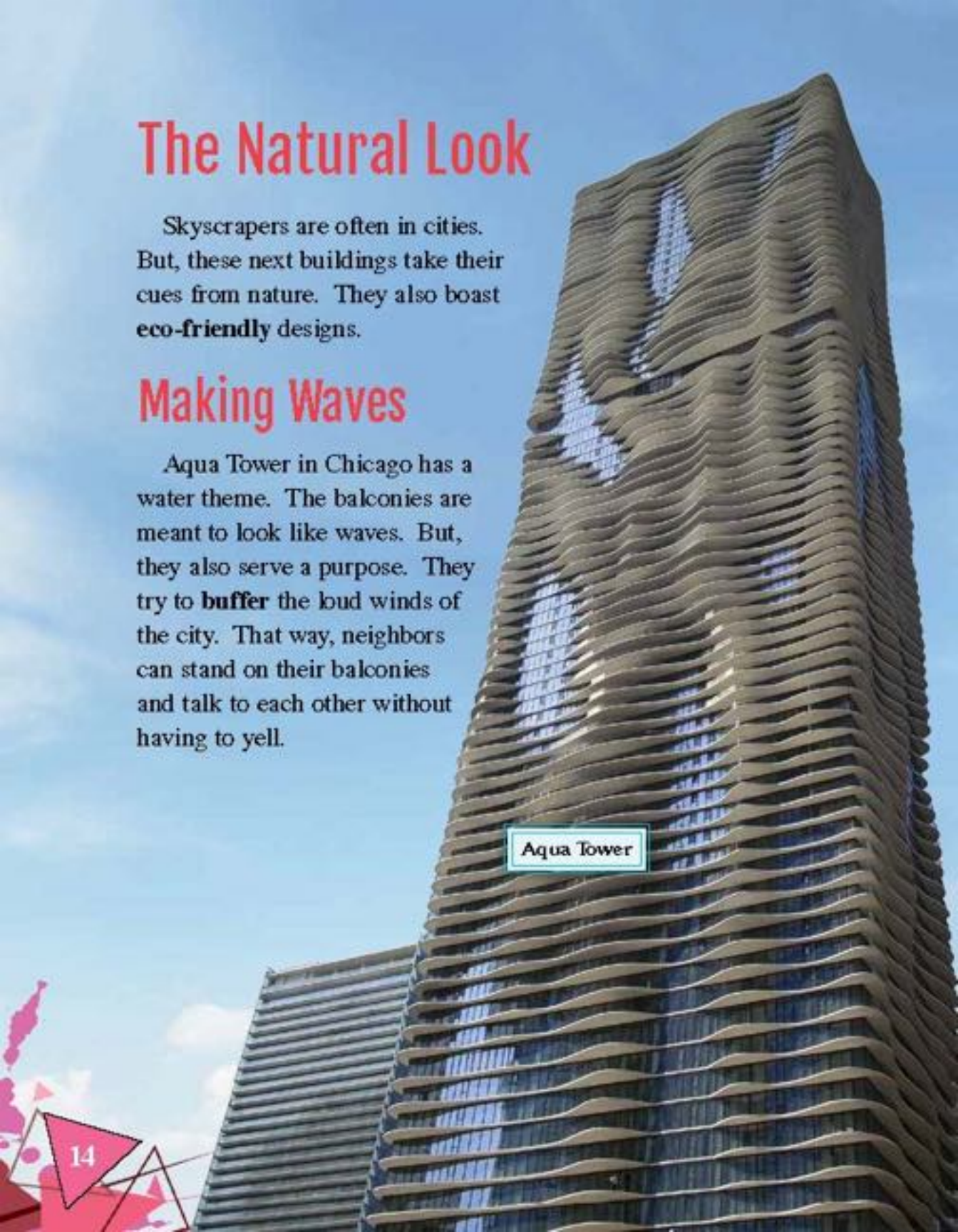

1. Find the area of the imagined dining room using at least two **strategies**. Which strategy is more efficient?
2. Find the area of the imagined meeting room using at least two strategies. Which strategy is more efficient?
3. Which room has a greater area?

# The Natural Look

Skyscrapers are often in cities. But, these next buildings take their cues from nature. They also boast **eco-friendly** designs.

## Making Waves

Aqua Tower in Chicago has a water theme. The balconies are meant to look like waves. But, they also serve a purpose. They try to **buffer** the loud winds of the city. That way, neighbors can stand on their balconies and talk to each other without having to yell.



# Prepping for the Job

Contractors must be ready to take on any challenge. One frequent request from clients is deck repair. First, contractors must gather information and plan what they want to do. That means they must inspect the space. By doing so, contractors can figure out the exact repairs that must be done.

Perhaps the wood is in good shape, but the paint is old. In that case, **refinishing** might be the answer. Or, a few boards might be damaged. Those can be replaced. If too many boards need to be replaced, a contractor might suggest building a new deck in its place. Perhaps the deck appears unstable. No one wants a deck to collapse while they are standing on it! In this instance, the deck's braces and posts must be checked. Contractors will then decide the best way to fix the problem.


unsafe deck


new safe deck

Contractors love to give good news to clients. In one case, a client's deck may be stable and safe. But, its floor needs to be refinished. And the top of the railing around three sides of the deck may be rotted. It needs to be replaced.

The contractor takes out a tape measure and measures some lengths. This is a vital part of the job. And doing this wrong could mean wasting a lot of time or money. It could result in a bad **reputation**.

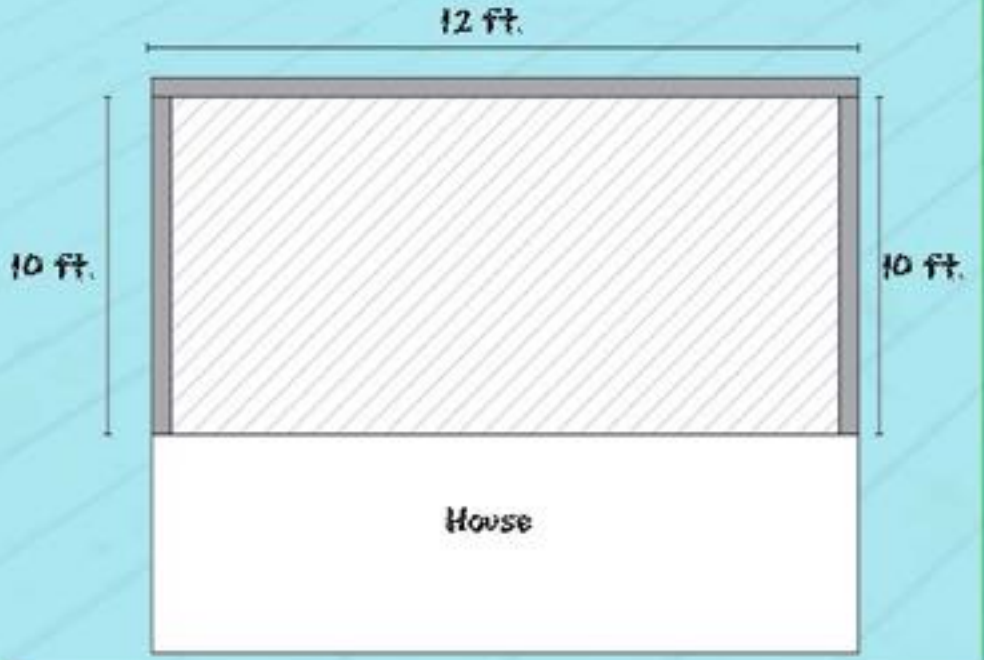
While measuring the railing, the contractor is sure to write a **linear unit**. If the contractor buys from a lumberyard that sells lumber by the foot, the contractor will order using that unit.

The contractor's next step is to measure the floor to plan for the correct amount of stain. For this, **square units** are used.

## LET'S EXPLORE MATH

While preparing an **estimate**, a contractor sketches a deck so that needed measurements can be recorded. One side of the deck does not need a railing because the house is there.

1. How many feet of lumber does the contractor need to buy for the railing?
2. How many square feet of the deck's floor will need to be covered by stain?
3. What is the difference between the linear units used to measure the railing and the square units used to measure the floor?



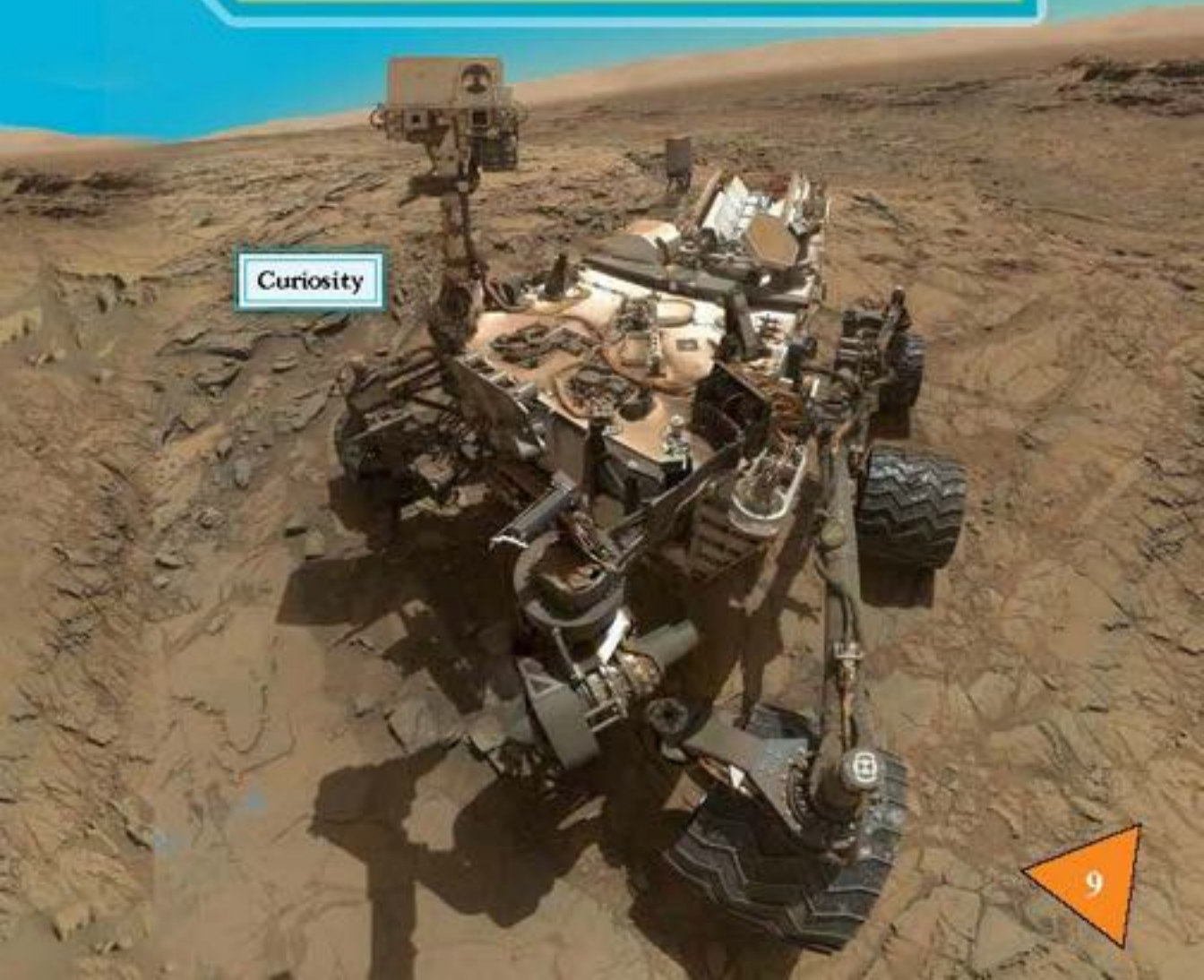
Contractors use math every day. They add, subtract, multiply, and divide. They also have to find the **perimeter** and **area** of spaces. *Perimeter* is a word with Greek roots. *Peri* means "around," and *metron* means "measure." So, it makes sense that the distance around the outside of a shape is called the perimeter.

When contractors need to find out how much railing a deck should have, they must measure the perimeter. They measure the distance around the deck. Once the lengths and widths are known, they are added together. This is the perimeter of the deck.

## Let's Explore Math

If Curiosity can travel 200 meters per day, how many days will it take to travel 800 meters?

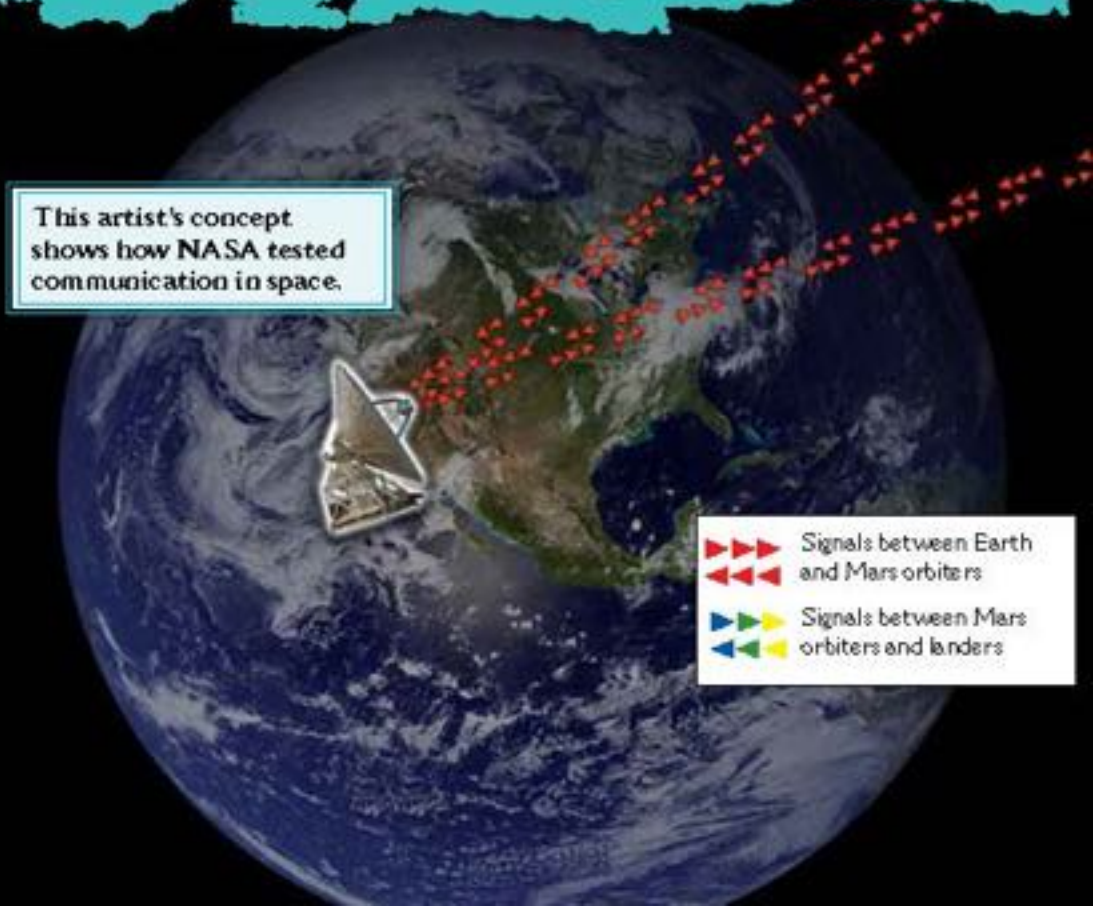
1. Write an equation and find the solution. Let $d$ stand for the days traveled.
2. Imagine that one of Curiosity's wheels is broken and will not turn. It can now only travel 100 meters per day. How many days will it take for the rover to cover 800 meters? Write an equation and find the solution, using $d$ to stand for days traveled.



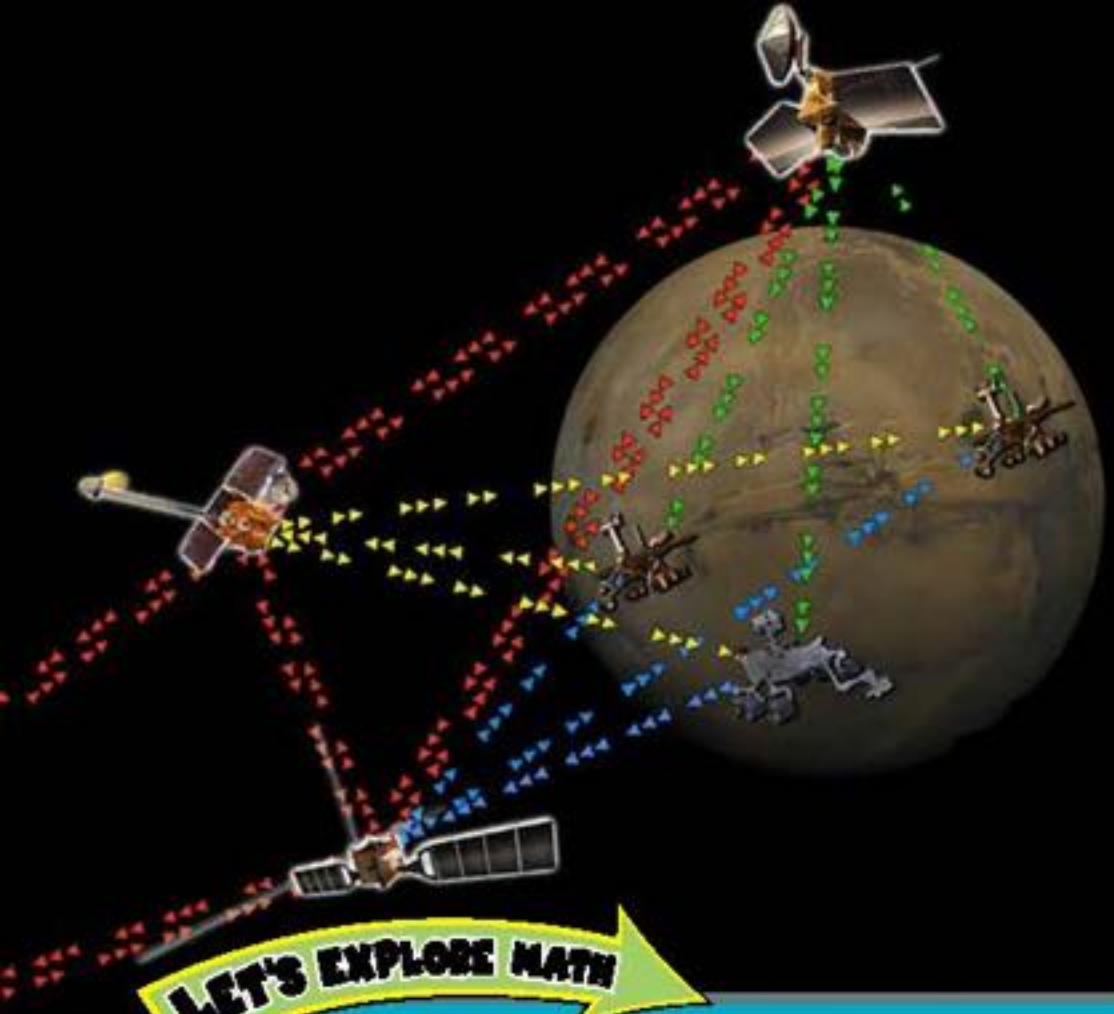
Curiosity

There are times when NASA loses all contact with rovers on Mars. This happens when Earth and Mars are on opposite sides of the sun. Loss of contact can last for over a month! This is one problem NASA wants to learn more about. People at NASA must learn how to stay in touch with the rovers. Once a crew gets to Mars, they want to be sure they can talk to them at all times.

As of 2016, NASA could send signals to the rover most of the time. And it sent signals back. But there was still a delay of 3 to 22 minutes. That long wait meant they would not be able to talk to a crew in real time. In an emergency, the Mars crew would be on its own for a while.




This artist's concept shows how NASA tested communication in space.



## LET'S EXPLORE MATH

If it takes at least 3 minutes to send a one-way signal from Earth to Mars, a round-trip signal would take 6 minutes.

1. How long would it take to send 6 round-trip signals?
2. When Mars and Earth are farthest from each other, it takes about 7 times as long to send signals. In these equations, $t$ represents the amount of time it will take. Which equation can be used to represent the time it would take to send 2 round-trip signals?

$2 \times 6 \times 7 = t$ $\quad$ $2 \times 6 + t = 7$

$2 \times 6 \times t = 7$ $\quad$ $2 \times 6 + 7 = t$

A geologist examines samples in the desert, using equipment that can be used in space.

# Exploring Mars-like Places

There are places on Earth where it is not easy to survive. The Arctic can be just as tough to live in as scorching hot deserts. Places like these can test a person's mental and physical strength. NASA knows that these can be the best places to research.

Much of Mars's surface has huge sand dunes. The Arizona deserts have those, too. So, a group of NASA scientists moved into an **analog** there. An analog is a shelter for living and working. It has conditions similar to those of space. This helps prepare people for Mars. Scientists can also wear gear and pretend they are on Mars. They can hike up sand dunes and collect samples. They can even use the same tools they will have on Mars.

## LET'S EXPLORE MATH

Imagine that the Mars crew has planted 11 pea plants in a desert greenhouse. Each plant can produce enough peas to fill 9 bowls. How many bowls of peas will the crew get in total from their harvest?

1. Estimate the number of bowls of peas the crew will be able to fill.
2. How many bowls will actually be filled? Use your estimate to check if your solution is reasonable.