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How Math Helps Us

Student Reader

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How Math Helps Us

Student Reader

Core Knowledge®

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How Math Helps Us

Table of Contents

Let's explore math in our world!

Math is everywhere . . . even in toys like a kaleidoscope.

Math helps us answer questions like . . . is this ecosystem healthy?

Math helps us have fun . . . like when planning and taking a hike.

Math helps us create . . . yummy chocolate cupcakes.

What else can math do?

Let's find out!

One Step at a Time

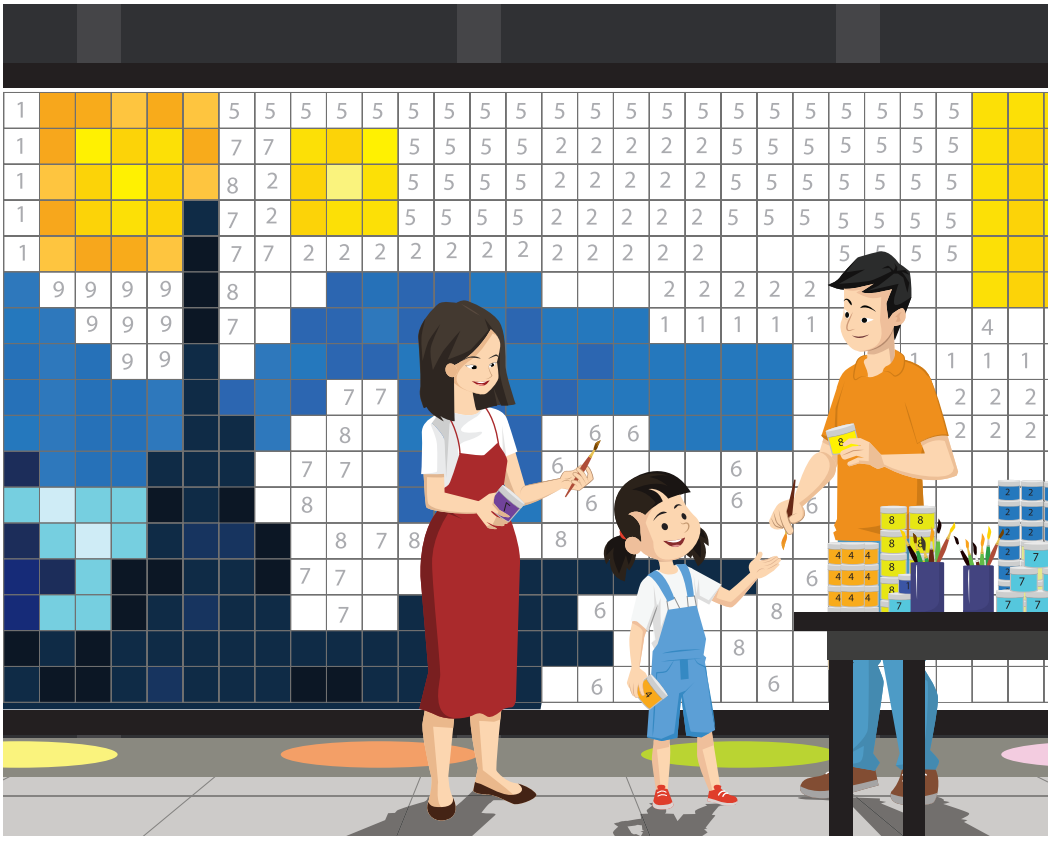
Chapter 1

Charlotte and her family are planning to go to a local art festival this weekend. She doesn't realize how much planning a festival takes! Before the festival begins, each artist is given a map of the festival grounds. The markings on the map show where different artist booths will be located. Each artist finds their own specific location on the map. Then they take their merchandise to the actual location to set up.

When Charlotte's family arrives, they first look at the sidewalk chalk art. Charlotte notices that one artist has drawn the wings of a butterfly. When he drew the image, the artist made sure that the wings were symmetrical like real butterfly wings. He made sure there was space between the wings for a person to pose. Charlotte lies down in the middle of the wings while her dad takes a picture. "That is definitely art made for framing," says Charlotte's mom.

The family visits other booths. There are many types of art at the festival, such as sculptures, paintings, and photographs. Charlotte's dad likes the art made with seashells. Her mom likes the pen drawings.

The next stop is a favorite for the whole family—the interactive mural. Each person picks a numbered paint can and a brush. The squares on the mural have numbers. Each person paints 10 squares that match the number on their can. Everyone can be a part of creating the art. Charlotte chooses an orange paint with the number 4. Her dad picks number 8, which is yellow. And her mom chooses number 2, which is a dark purple. Each of them is excited to paint.



After Charlotte's family paints their 10 squares on the mural, they head over to an artist drawing special portraits called caricatures. When Charlotte's turn comes, she sits down. The artist asks Charlotte questions about things she likes and her hobbies. This helps the artist know what to include in the portrait. The artist must figure out how to fit everything on the page.

The next booth the family visits has art books for sale. Charlotte sees a step-by-step drawing book. It shows how to draw different animals one step at a time. Charlotte buys the book and is excited to get home and create some art of her own! On the way home, Charlotte's mom says, "Once we get home, I'll put together your desk. This way you will have a place to do your drawings."

When Charlotte gets home, she looks through her new book and finds the first animal to draw. Her mom is busy carefully reading the instructions for the desk. “Mom, you put things together at work. Why do you need the instructions for the desk?” asks Charlotte.

Her mom replies, “I always use instructions because they show me all the pieces and how many of each I will need. They tell me what to do with those parts. Each thing I need to do is written as a separate step. If all the steps aren’t completed, your desk might fall apart.” Charlotte thinks for a moment and says, “Mom, please use the instructions.” They both laugh.

After her desk is put together by her mom, Charlotte gets busy drawing. She props her book on a stand. She carefully looks at the steps before drawing. Then she draws the first step, which is the penguin's body. Next she will add the bird's face, and then its flippers. Another oval makes the penguin's belly. After she draws the penguin's feet, she will color herdrawing.

Main Idea

Plans have steps that must be followed to complete a goal.

Farmer Quinn

Chapter 2

Winter has settled over Green Grove Farm like a soft blanket, covering the fields with a layer of snow and quiet.

But Farmer Quinn's mind is not quiet. In fact, it is filled with activity. He is excited as he thinks about the upcoming growing season.

For Quinn, running a farm isn't just a way to make a living. He grew up on the farm. He feels connected to the land. He loves the way each season has its own work that needs to be done.

"There's no planting without planning," Quinn's mom always said when Quinn was growing up. She made sure Quinn understood that winter farm work was just as important as planting seeds or watering crops.

As he sits at his desk to plan for the upcoming spring planting season, Quinn looks over notes and reflects on last year's growing season. He recalls the rows of crops stretching out before him. Corn, with its tall stalks, should be planted in rows spaced 3 feet apart. This way, each plant has plenty of room to spread its roots. Low-growing bean plants should be placed in rows 2 feet apart. Every plant is arranged to meet its own needs. Knowing how much space he has and how much room each plant needs helps Quinn calculate the number of seeds he'll need to buy.

As the days grow longer, the snow begins to melt. Quinn's excitement for the coming spring planting season grows. Most days, he works inside the greenhouse. He plants tomato and pepper seeds in trays full of small, soil-filled pots. He drops 2 or 3 seeds into each pot and gently covers the seeds with soil.

The plants need to develop strong roots before they are planted in the fields.

Over the next few weeks, seeds in those soil-filled pots sprout and grow their first leaves. Trays of tiny tomato seedlings fill the greenhouse. Quinn carefully tends to each tray. He keeps the soil damp and gives nutrients to the small plants. He thins them so that only one plant remains in each pot. “Plants don’t like to be crowded,” he thinks. “They need room to grow!”

As spring marches on, Quinn turns his attention to the fields. Since the plants must be transferred from their pots to rows in the fields by hand, Quinn hires extra workers to get them planted on time. Half of Quinn’s farmland is planted with corn—using about 35,000 seeds per acre! He also plants sunflower and bean seeds.

Water is very important to farming. The transplanted seedlings need water to grow. Soil has to be damp so the seeds sprout. Quinn hopes spring rain does most of the work.

Now it's time for Quinn to plant his tomato and pepper seedlings in their fields. He only has a few plots of land devoted to these crops. Quinn knows how much room each plant needs to grow to its greatest potential. He determines the length and width of each plot for each type of plant and uses this information to make an array. The array shows his workers how many rows to plant, how far apart to make them, and how many plants to place in each row.

As the summer sun warms the fields, Quinn watches with pride as his crops grow. The cornstalks stand straight and strong in their rows. The bean plants stretch out their leaves. The sunflowers bloom. The tomatoes and peppers produce large, ripe fruit.

As fall approaches, the work of harvesting begins. More workers are hired, and Quinn has used math to budget how much he will pay them. Each day, Quinn watches the morning weather report anxiously. He waits for the perfect time to harvest the corn. Once the corn is ready to be picked, dry weather is best for getting the crops out of the fields and into storage.

The harvest is good. Quinn takes boxes of tomatoes and peppers to the farmers market each week. He brings the extras to local stores. There are rows of boxes stacked in his barn and ready to go. He can fit about 20 peppers in each box. He knows that if he multiplies the number of boxes by 20, he'll know how many peppers he has to sell.

Finally, the last of the harvest is gathered. Farmer Quinn walks around the empty fields and thinks about the year. For just a moment, he pauses and lets himself enjoy a sense of satisfaction.

Then the moment passes. Quinn's mind turns to plans for next year. What can he do to improve his plan from this year? Will he plant more beans? Will he try a different type of corn? There are decisions to make!

Just as Quinn's mother taught him, there will be no planting without planning.

Main Idea

Farmers use different types of math operations to plan, grow and harvest crops, and manage their farms.

Poetry Patterns

Chapter 3

What do you think about when you hear the word *poem*? You may think about words and rhymes. But there is a partner in poetry that isn't as obvious. It's math!

Many poems are divided into groups of lines called stanzas. Another word for stanza is *verse*. Some poems have 2 lines in a stanza. Two-line stanzas are called couplets. Other poems have 3, 4, 5, or even 6 lines in a stanza. Usually, a poem has the same number of lines in each of its stanzas.

This poem is by the English poet Christina Rosetti (1830–1894). How many stanzas does it have? How many lines are there in each stanza? What else do you notice about this poem?

Who Has Seen the Wind?

Who has seen the wind?
Neither I nor you:
But when the leaves hang trembling,
The wind is passing through.

Who has seen the wind?
Neither you nor I:
But when the trees bow down their heads,
The wind is passing by.

Robert Louis Stevenson (1850–1894) was born in Scotland. He wrote many short stories and novels. He is well known for writing poems like this one for children.

The Cow

The friendly cow, all red and white, I love with all my heart: She gives me cream with all her might, To eat with apple tart.

She wanders lowing here and there, And yet she cannot stray, All in the pleasant open air, The pleasant light of day;

And blown by all the winds that pass And wet with all the showers, She walks among the meadow grass And eats the meadow flowers.

As you read, try to answer these questions: How many stanzas does this poem have? How many lines are in each stanza? What do you notice about the rhyming pattern? Compare the last stanza to the other two. Can you spot the difference?

Some types of poems follow a special pattern. All haiku poems have just 3 lines. Each line has a certain number of syllables.

- The first line has 5 syllables.
- The second line has 7 syllables.
- The last line has 5 syllables.

In total, a haiku has 17 syllables. A haiku is different from some other poems because it doesn't rhyme.

Matsuo Bashō (1644–1694) was a famous Japanese poet. He is known as the greatest master of the haiku. In the beginning, haiku poems were all about nature.

An old silent pond . . .
A frog jumps into the pond,
Splash! Silence again.

Here are more haiku poems by Matsuo Bashō:

On sweet plum blossoms
The sun rises suddenly.
Look, a mountain path!

On a withered bough
A crow alone is perching;
Autumn evening now.

Today, these poems are not all written about nature. But they all still follow the 5-7-5 rule. Here's a haiku about math:

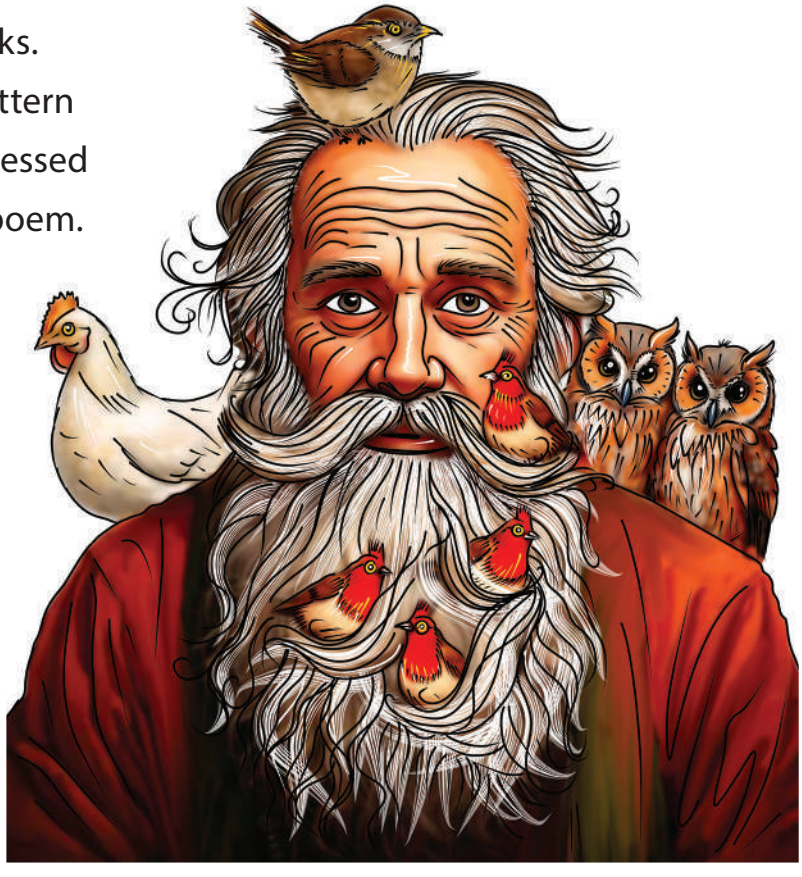
My favorite class—math!
Searching for the right answers,
Puzzles to be solved.

Another special type of poem is the limerick. A limerick has 5 lines in a stanza. The first, second, and fifth end in a rhyme. The second and third lines end with another rhyme.

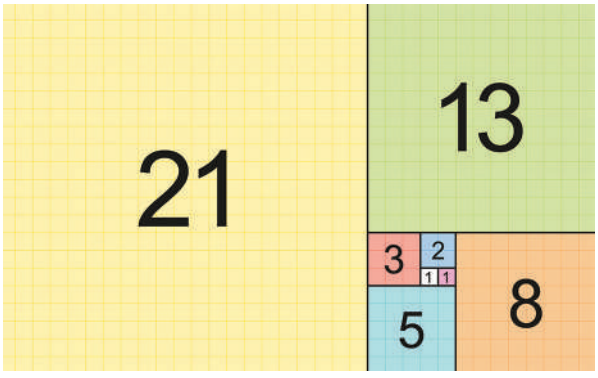
Edward Lear (1812–1888) was an English artist, musician, and author. He also wrote playful poetry! Here is one of his more famous limericks:

There was an Old Man with a beard,
Who said, "It is just what I feared!
Two Owls and a Hen,
Four Larks and a Wren,
Have all built their nests in my beard!"

There is something else special about limericks. The rhythm is the pattern of stressed and unstressed syllables within the poem. The rhythm is the "beat" of the poem. Read the limerick again, line by line, and count out the syllables. The lines are designed to follow a certain rhythm. This is also called the meter of the poem.



There are even poems called Fibonacci poems! The syllables in each line are based on the Fibonacci sequence. Remember that the Fibonacci sequence is a series of numbers in which each number is the sum of the 2 preceding numbers.



You can't show "0 tiles" in a picture of a Fibonacci sequence. So this representation begins with 1.

The sequence starts with 0, but there can't be a line with 0 syllables. This means the first line has 1 syllable. The second line has 1 syllable (0 + 1 = 1). The third line has 2 syllables (1 + 1 = 2). The fourth line has 3 syllables (1 + 2 = 3) and so on. Most Fibonacci poems have 6 lines, but some are longer. A 6-line Fibonacci poem has 20 syllables with a line-by-line count of 1/1/2/3/5/8. Here's a Fibonacci poem about writing a poem!

I
write
haiku.
Three lines long.
Seventeen counted
syllables—five, seven, and five.

Next time you read a poem, look for the math! You are sure to find some!

Main Idea

Rhythm, rhyme, and patterns are found in poetry.

Six Symmetry Sightings

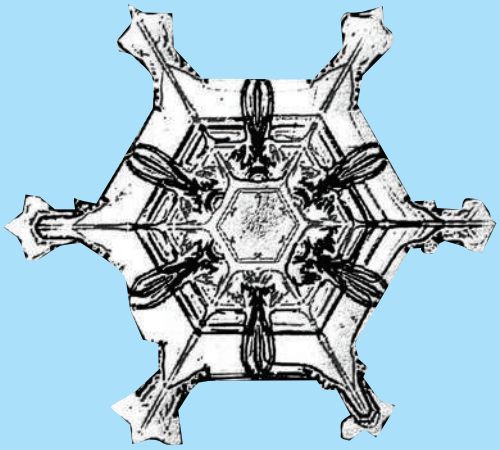
Chapter 4

Butterflies and Their Beautiful Wings

Butterflies are famous for their stunning symmetry. This means that if you fold the wings in half along the length of a butterfly's body, the 2 wings match perfectly. The wings have intricate patterns and colors, but each wing is a reflection of the other wing. The wings are mirror images. This mirror symmetry helps butterflies in many ways. It allows them to fly straight and might even confuse predators into thinking both wings are part of a larger, scarier creature. Butterfly wings are one of the easiest places to spot symmetry in nature. Next time you see a butterfly, take a closer look—you're seeing math and nature working together!

Snowflakes: Nature's Frozen Art

Snowflakes are tiny works of art that show 6-sided symmetry. As water freezes in the clouds, its particles arrange themselves into patterns. No two snowflakes are exactly alike, but they all have 6 sides or arms that spread outward evenly. Can you see how each snowflake can be folded in half different ways and that each half is still a mirror image? Next time you catch a snowflake on your mitten, look very closely before it melts. You're holding a tiny, symmetrical 6-sided piece of art.



Sea Stars and Their Radiating Arms

A sea star is another example of symmetry. Its body parts are arranged like spokes on a wheel, with its arms extending outward from the center. This is called radial symmetry. Most adult sea stars have 5 arms, but some types have more. This symmetry helps them move in any direction and easily grab food. Not only is star symmetry practical for the animal, but it is also beautiful. If you visit a tide pool or an aquarium with sea stars, take a moment to appreciate how perfectly balanced and even they look.

Flowers: Petals in Perfect Order

Many flowers, such as daisies and sunflowers, have symmetry in which their petals are evenly spaced around their centers. This symmetry isn't just for looks—it helps flowers guide pollinators like bees and butterflies. The neat arrangement of petals makes it easier for insects to land and find nectar. In return, the pollinators help the flowers grow more plants. Whether you're in a garden or a park, you're surrounded by the mathematical beauty of flowers.

Animal Patterns: Stripes and Spots

Many animals have patterned fur or feathers making one side of their body mirror the other. For example, a peacock's spotted feathers are arranged symmetrically across its tail. It makes for a stunning display. The peacock's tail attracts attention. In contrast, the stripes of a tiger's fur help it blend into its surroundings. Symmetry in animal patterns is both beautiful and functional.

Human Faces: A Familiar Symmetry

Did you know that your own face is an example of symmetry? Hold up a mirror to one side of your face, and you'll see how the other side reflects it. While no face is perfectly symmetrical, the general shape of your eyes, nose, and mouth is balanced. Scientists think that symmetry in faces plays a role in how we recognize and find beauty in one another. Next time you look in the mirror, you can see many examples of symmetry in your own reflection.

Main Idea

Symmetry in nature not only is beautiful but has other uses as well.

Do-Si-Do

Chapter 5

"Do-si-do!"

"Swing your partner!"

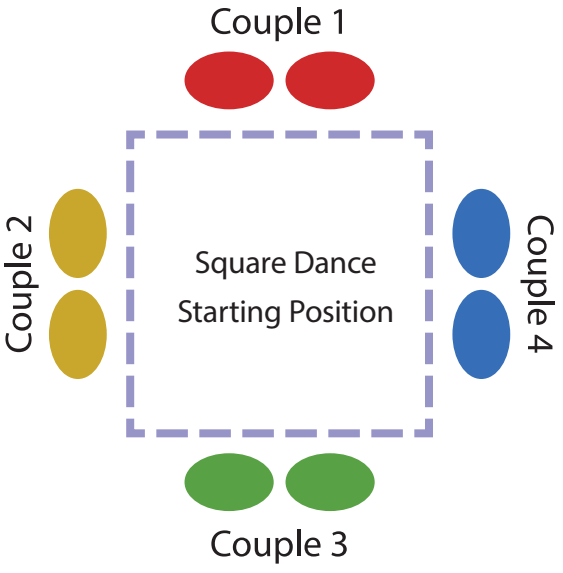
"Now promenade!"

Where might you hear these phrases? That's right: at a square dance!

In a square dance, dancers begin by forming a square. That's where this kind of dance got its name. It's different from other kinds of group dancing. For example, in line dancing (you guessed it!), dancers form long lines. And in a round dance, dancers form a circle.

To form the beginning square, you need 8 dancers that are organized into 4 pairs. Dancers arrange themselves on the 4 sides of a square, with 2 dancers on each side. If you happen to have an odd number, one person will need to find a friend!

Where did square dancing come from? Well, square dancing is a traditional American folk dance, but its roots are in European folk dances, such as the French cotillion. The cotillion was danced by 8 people in a square formation, just like the American square dance.



As Europeans came to the United States, they brought their folk dances with them. Over time, the dances changed. Parts of different European dances mixed together. Indigenous and African dances and music added to the mix.

When it began, square dancing was a community activity. Neighbors would gather for events and celebrations. Musicians would play lively tunes. Square dancing was a way for neighbors to have fun together and to build a sense of connection and belonging. From the late 1940s through the mid 1970s, square dancing was taught in many schools' physical education programs. But by the late 1970s, its popularity had faded, and many schools stopped teaching the steps and patterns of the dances. Even so, nearly half of U.S. states have some form of square dance as their state dance, and square dancing is celebrated annually on November 29, National Square Dance Day!

Square dancing is still practiced today. Many communities have square dancing clubs. You might find square dancing at summer fairs and festivals.

Dance Logic

Why can't a square dance work with 7 dancers?

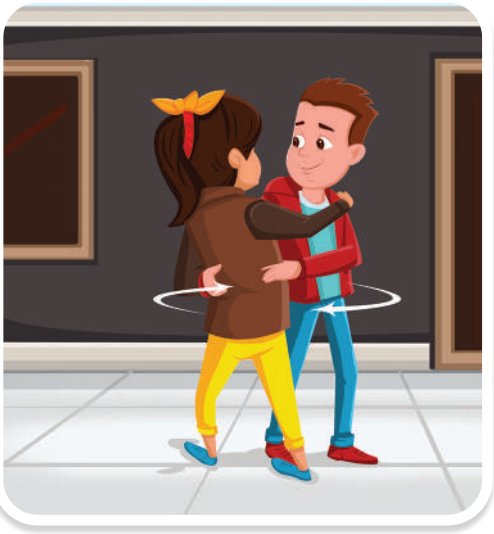
A square dance involves a series of movements that form patterns and shapes, such as squares, circles, and stars. However, the dance always begins with a square.

A caller is the person who leads the dance—not by dancing but with words. Their directions guide dancers through a sequence of moves such as swings, promenades, allemandes, and do-si-dos. You can see some examples of these moves on the following page.

Dancing Shapes

If partners must start the square dance together, how many dancers are needed to make a square to start? How can you plan how many dancers you need to make more than 1 square?

Getting Started with Square Dance



During a swing, partners rotate around each other.

A do-si-do involves pairs passing each other back-to-back.

An allemande has dancers join hands with a dancer to the left or right and then circle each other once.

A promenade involves pairs holding hands and walking together around the edge of the square.

Square dance music is fun and full of energy. It may include folk tunes or country melodies. Musicians often use instruments such as the fiddle, banjo, and guitar. The music sets the upbeat pace and mood for the dancers. It helps them all move together as they dance. Dancers coordinate their motion according to the rhythm, or beat, of the music.

Music is another way square dancing is all about even numbers! Most square dance music is organized in groups of 4 beats. As dancers do the steps, they might even count to 4 over and over in their heads!

Square dancing is a great way to meet new people or have fun with friends. Dancers of all ages and backgrounds can come together to enjoy dancing as a group.

Main Idea

Rhythm and patterns are used in dancing.

Friends of the Frog

Chapter 6

The town of Willowbrook is a wonderful place to live! The town leaders think it is time to build more apartment buildings to grow the town.

Willowbrook is home to many lakes and ponds. However, the town residents are worried that all the new apartment buildings being planned could harm Willow Lake because it is close to the building site.

The town council decides to ask a team of scientists from the nearby university to investigate the health of Willow Lake and the creatures that live there. The team is led by Dr. Maya Juarez.

At a town council meeting, Dr. Juarez expresses how happy she is that the town is checking the health of the lake before it builds. She explains the work the scientists will do.

"We will be taking samples of the water and soil around the lake. And we will be counting frogs," she says.

"Frogs?" asks Mayor Spangler.

"That's right," says Dr. Juarez. "Frogs are very sensitive to pollution. When water is polluted, frogs become unhealthy. We know that a healthy lake has lots of healthy frogs. If we don't see many frogs or we find too many unhealthy frogs, the lake itself is likely polluted."

"But how can you possibly count all the frogs in a lake? That seems like it would take a long time!" says Mayor Spangler.

The town council members nod in agreement, looking puzzled.

"That's a great question," says Dr. Juarez. "You see, we don't count every frog! That would take far too long! What we do is *estimate* the number of frogs."

"Ah, estimating!" says Mayor Spangler.

"Right! So we divide the frog habitat around the lake into equal-sized squares. We count the number of frogs in 1 square. Then we multiply that number by the number of squares in the whole area. That gives us an estimate of the total population of frogs in the lake."

"Thank you for that explanation," says Mayor Linda. "We are excited to have the help of your team!"

Handy Estimates

An estimate is a rough way to judge or calculate something. It is a great way to avoid counting items one by one. How might you use Dr. Juarez's method to estimate the number of rocks at the bottom of a fish tank?

The next day, Dr. Juarez and her team begin their work. First, they divide the frog habitat around the lake into equal-sized squares. There are 50 squares at Willow Lake.

Next, they capture and count the frogs from 1 of the squares at the lake. In total, they capture 20 frogs from Willow Lake.

They also observe the health of each frog they catch. If any frog seems unhealthy, the scientists record that information. If there are too many unhealthy frogs, the scientists will suspect there is pollution in their environment.

The scientists bring all the data back to the lab to review.

"Well," says Dr. Juarez looking at the frog data they collected, "at Willow Lake,

Bring this line up to the previous line. We found 20 frogs in 1 square. The lake is 50 times larger than the area where we caught those frogs. So I estimate that Willow Lake has around 1,000 frogs living near it. We also observed that there were 9 unhealthy frogs near Willow Lake. Along with the samples we collected from the area, this data tells us about the health of the lake."

Armed with their data, the scientists present their findings to the town council.

"So you see, Willow Lake is showing signs of being a very healthy lake. 1,000 frogs is a nice number for a lake that size. And 9 unhealthy frogs out of 1,000 is not very many at all," says Dr. Juarez. "This is good news, but the town may want to be careful when it plans to build. The habitat there should be checked periodically to make sure the lake remains clean while the apartment buildings are being built. I recommend placing a silt fence around the lake while you are building to help protect Willow Lake."

"That is good advice," says Mayor Linda. "We will keep an eye on the building projects near the lake. We would like your team to come back next year and see how well we have done."

"We'd be happy to!" says Dr. Juarez. "It is good to work together to keep our environment healthy!"

Main Idea

Estimating is a way of making a good guess about a number of something that is difficult to count precisely.

Concert for a Cause

Chapter 7

Marcus, Nora, Max, and Yami are helping their teacher plan a concert competition. Groups are coming from all over the city to compete. The event will raise money from ticket sales to help support the school music program.

"Here are all the entry forms," says Yami. "We've got 12 groups coming! We need to make a schedule for the performances."

"Wow," adds Nora, "12 groups means a lot of performers! Where will they all prepare? We need to figure out whether they will all fit backstage. Each group needs to know when to perform and where to be before and after that."

"And . . . we need to keep track of how many tickets we sell," says Marcus. "We'd better get started!"

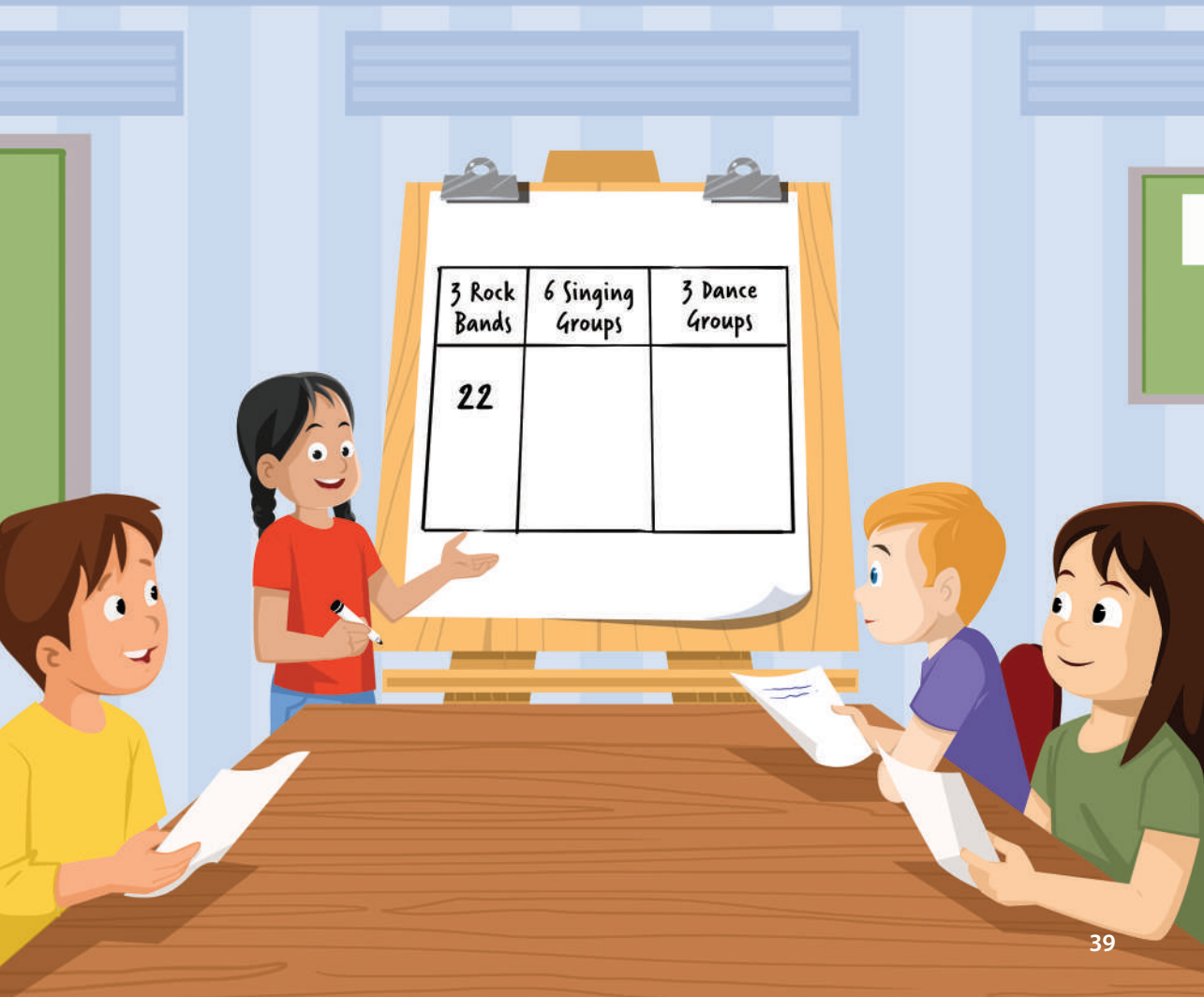
"OK," says Yami. "The groups are divided into 3 categories—rock bands, singing groups, and dance groups. We can keep track on this chart." She points to the chart paper.

The team separates the forms by category. There are 3 rock bands, 6 singing groups, and 3 dance groups. "We can use the forms in these piles to see how many people are in each group," says Max.

"Good idea," says Yami. She picks up the first pile. "It looks like 2 of the rock bands have 5 people, but 1 has 12."

"Maybe the large one has a horn section!" Nora says with a laugh.

Yami adds 22 under "Rock Bands" on the chart.



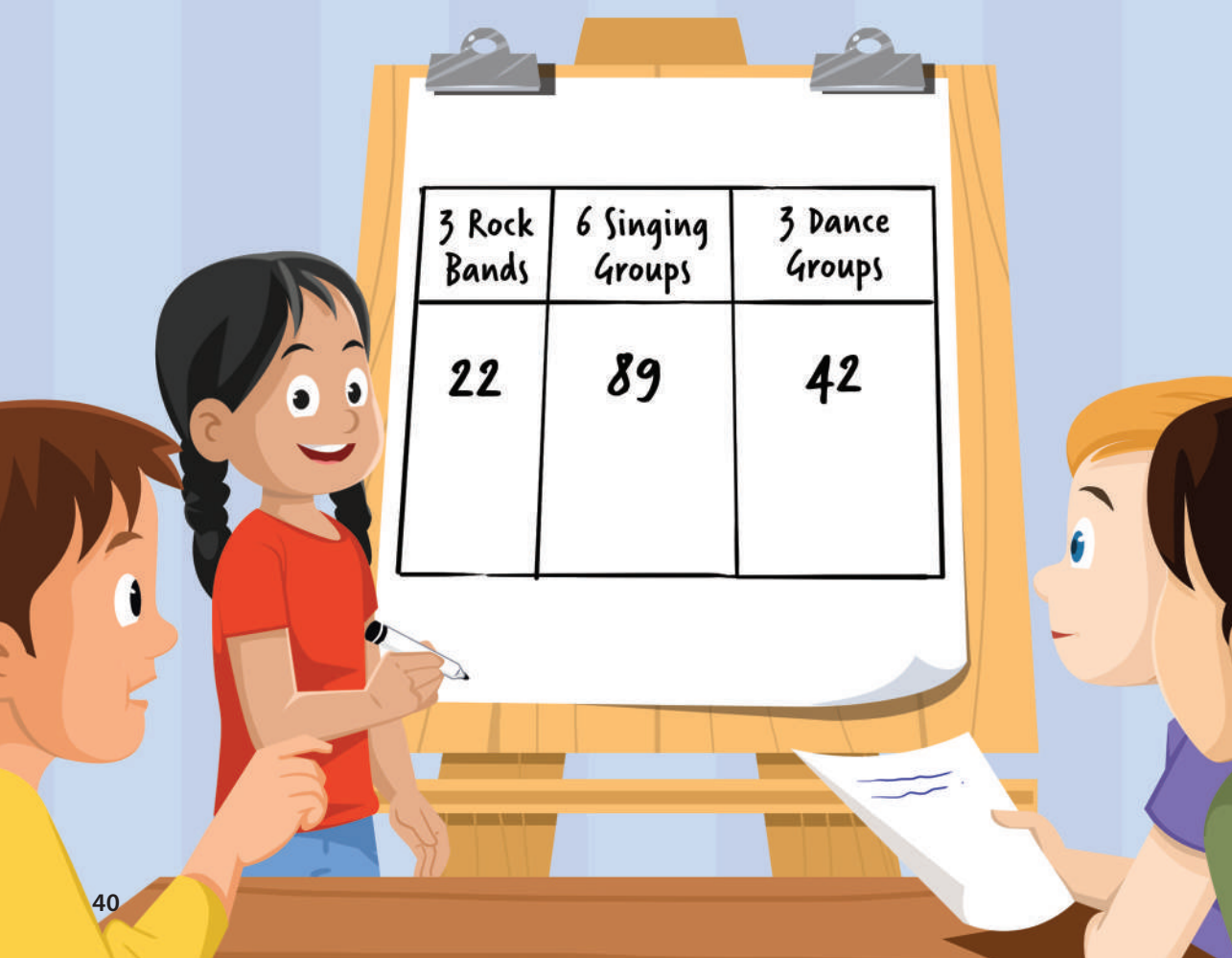
Nora chimes in, "We can add up the people in the 6 singing groups. There are 89 singers in total. Let's add that to the chart."

"Great! Now let's count the people in the 3 dance groups," says Marcus. One of the groups has 18 people in it! The other two each have 12 people. That means there will be 42 dancers."

Nora looks surprised. "Look at the chart! When we add them all up, there will be 153 performers! Whew! That is a lot of people roaming around backstage!"

Yami points out, "If the groups have a schedule for when they perform, they don't all need to be backstage getting ready at the same time."

"Good point, Yami," says Nora. "Maybe we'll be all right after all."



The students design a schedule that shows when each group will perform. For each group, the schedule includes 5 minutes to perform and extra time to set up before and to clean up after their performance. They even include time for an intermission. A week before the concert, Yami shows her friends her notes on ticket sales. "We're almost sold out!" she exclaims. "We've sold 475 tickets!"

"There are only 500 seats in the concert hall," says Max. "We'll definitely run out of tickets soon."

"I wonder if we can add a second concert," adds Marcus.

"Great idea," says Nora. "I'll talk to Mrs. Lee about it."

A Good Plan

Subtracting the total number of tickets sold from the number of seats in the concert hall shows the friends that their concert is almost sold out.

On the evening of the second show, the friends discuss how the event has been going. “What a great idea to have a second show,” says Max. “I think the performers loved it also.”

“This second night isn’t sold out, but it is pretty close!” says Yami.

“And knowing our numbers, we planned it well so that the performers seemed to have enough room to come and go backstage,” says Marcus.

Later that week, the friends present their check for $9,780 to the school principal.

"The concert sold 978 tickets, so we'd like to present this check to help support the school music program," says Yami. Everyone applauds for the support the students have given the school.

Marcus's mother is there in the crowd to cheer the children on. "I know what you kids deserve after that amazing act," she says. "Ice cream!"

"Thank you," says Nora. "We worked hard, so now we get to celebrate!"

Main Idea

Operations with math are important tools for solving real-world problems and making real-world plans.

Trail Tales: A Hiker's Journal

Chapter 8

Day 1: Arches National Park

Today marked the beginning of my long-awaited journey along the Hayduke Trail. I was up with the sun and saw the first light of dawn paint the sky pink and gold. I heaved my backpack onto my shoulders. Thanks to my months of planning, the pack holds everything I need at a weight that I can manage. I trained by practicing short hikes with this much weight for weeks. I have planned for a hike of around 313 miles. It won't be the whole trail, but it will be my longest hike yet. Today, I got started with a shorter hike of about 15 miles.

Day 3: Near the Colorado River

Today was clear and warm. With each step, I marveled at the beauty of the wilderness surrounding me. I walked through a rugged landscape. I covered about 33 miles the first 2 days. I hiked another 18 miles today. I estimate that I have about 260 miles remaining.

Day 6: Canyonlands National Park

Today, as I walked, I really felt the weight of my backpack pressed against my shoulders. It is a reminder that the things I carry keep me alive. My tent, weighing 4 pounds, protects me. My sleeping bag, at 3 pounds, keeps me warm at night. My cooking stove and fuel weigh 8 pounds. Three quarts of water weigh around 6 pounds. And food, of course! I mentally estimated the weight of the meals and snacks I carried. I only needed to carry enough to get to the next resupply point. When you include clothing, camera, notebook, extra water filter, first aid kit, compass . . . it adds up! The total weight of my pack affects how fast I can go. I need to not overload so I can stay on schedule. I made it 47 miles on Days 4–6. When I include this with my totals from Days 1–3, I have about 210 miles left!

Day 14: Poison Spring Canyon

I've had some trouble with my ankle, so I've been moving more slowly the past few days. But I've made it about 190 miles of my total hike. Passing the halfway mark a few days ago sure felt good!

Each evening, as I pitch my tent and settle in for the night, I reflect on that day's journey. While on the trail, I mentally estimate my miles. At the end of the day, I calculate the actual miles I've hiked to figure out the distance I have left to go. I like to check how close my estimates are. Each day brings me closer to my goal. While I take time to enjoy the views during the day, somehow this nightly ritual gives me a sense of pride.

Closer and Closer

When the hiker adds up distances mentally, they can make estimates. Each estimate tells how much closer they are to their goal.

Day 17: Capitol Reef National Park

I decided to take a rest here at Capitol Reef National Park. It's so beautiful. I wanted to take some photos, and I needed to give my ankle a rest! But the rest didn't last long. I was soon on my way again.

Some of the trails are steep! During these steep climbs, I measure my progress not just in miles but in elevation. The physical exercise becomes more challenging as I climb 1,000 feet higher—2,000 feet higher—3,000 feet higher. On and on! I feel like I'm climbing into the sky! As I move upward, my legs burn with effort. But the amazing views from the highest points make every step worth it.

Day 20: Coyote Gulch

I'm getting close to my goal. It's been tough hiking but beautiful. One tricky thing has been having to carry more food supplies, since this part of the hike has fewer resupply stops. More food means more weight in the backpack. Of course, as you eat the food, the pack gets lighter!

The same thing is true of carrying water. Each time I stop to refill my water bottles, I feel their extra weight. Six pounds is a lot when you're walking over rocky ground in the sun. As I drink the water, I feel that weight lighten. Heavier, lighter, heavier, lighter.

Day 23: Escalante

Today, I reached the end of my hike. I'm in a small motel in the town of Escalante, Utah. It's amazing to be in a real bed after taking a hot shower. Did I mention that I immediately ate a hamburger after reaching the town? So tasty!

As glad as I am to have completed my hike, I'm already planning my next one. I think the next part I'll tackle will be from here to Zion National Park in Utah. I've heard it is just beautiful! For now, though, I'm enjoying this soft pillow!

Main Idea

Hikers continually add and subtract weights and distances.

Baking with Nadia

Chapter 9

Welcome to the best cooking show on TV, *Baking with Nadia*! Today, we're going to satisfy our sweet tooth! We'll be making a yummy treat—the perfect chocolate cupcakes. But before we dive in, let's talk a little bit about how math helps us make crunchy cookies, mouthwatering muffins, and creamy chocolate cupcakes.

Before we bake, we need a plan. In baking, we call our plan a recipe! Without this plan, our cake can flop. Once we have the recipe, the fun begins. Let's check our math toolbox and see what we need.

In baking, measuring is key. We measure ingredients carefully to make sure our recipes turn out just right. Take flour, for example. One cup of flour might not seem like a lot. But it's just the right amount to give our cupcakes a light texture. If we add too much flour, our cupcakes will be too heavy. If we add too little, our cupcakes will be too wet and sticky.

Let's take a look at our recipe. Fear not; even a recipe that seems complicated happens just one step at a time! This is an old family favorite. Notice that the recipe not only lists ingredients and tells us quantities but also tells us the order the steps are carried out.

Chocolate Cupcake Recipe

Prep Time: 20 minutes; Cook Time: 30 minutes; Makes 24 cupcakes

2 cups flour

2 cups sugar

$\frac{2}{3}$ cup unsweetened cocoa powder

2 teaspoons baking soda

1 teaspoon salt

2 eggs

1 cup milk

1 cup vegetable oil

1 $\frac{1}{2}$ teaspoons vanilla extract

1 cup hot water

2 cans store-bought chocolate icing

Directions

1. Preheat the oven to 350 degrees F.
2. Grease and flour 2 12-cup muffin pans, or place liners in the pans.
3. In a large bowl, stir together flour, sugar, cocoa, baking soda, and salt.
4. Add eggs, milk, oil, and vanilla to a separate medium bowl and stir to combine.
5. Add the wet ingredients to the dry ingredients, and mix for 2 minutes with an electric mixer on medium speed.
6. In a mug, heat 1 cup of water in a microwave on high for 2 minutes.
7. Stir the water into the other ingredients. The batter will be thin.
8. Pour the batter evenly into the prepared muffin pans.
9. Bake in the oven for 18–22 minutes.
10. Cool for 5 minutes, then remove the cupcakes from the pans.
11. After the muffins are completely cool, frost with store-bought icing.

The recipe tells us that we will need some special equipment to make these cupcakes. I make note of this and double-check that we have everything.

Before we begin, I collect everything we need and put it on the counter. I like to measure everything out before I start, so we'll need containers for each ingredient. We start by measuring out 2 cups of flour and 2 cups of sugar and putting them in a medium bowl. Next, we need $\frac{2}{3}$ of a cup of cocoa. We can add that to the same bowl as the flour and sugar. This is where I am glad we know our math! I don't have a measuring cup that holds $\frac{2}{3}$ of a cup. But I have a $\frac{1}{3}$ of a cup measuring cup. We can use the $\frac{1}{3}$ of a cup measuring cup and simply fill it up 2 times. This will give us $\frac{2}{3}$ of a cup of cocoa. Just remember to count carefully and not lose track! If we don't have the exact measuring tool we need, that's OK! We can use the tools we have to make the correct amount. Let's go measure out the rest of the ingredients!

It can sure seem like there is a lot of math in baking, but it's only a little at a time. Notice that some of the ingredients are measured with measuring spoons. We need to be extra careful with measuring the baking soda and salt. We need 2 teaspoons of baking soda and only 1 teaspoon of salt. We sure don't want to make our cupcakes too salty!

Now that we have our ingredients measured out, let's start baking. All of the steps in the recipe are important, but there won't be any cupcakes if we don't start with step 1. We turn the oven to 350 degrees F so that it will heat up as we follow the other steps. Don't forget that it is really important to follow the steps in order. Sometimes, I mark them off the steps after I complete them.

One thing that recipes never tell you is that you need oven mitts to take things out of the hot oven. You don't want to burn yourself!

People often ask me what to do if they want to make more cupcakes or fewer cupcakes than the recipe makes. If you use your math skills, it's easy! If I want to make 12 cupcakes instead of 24, I divide each ingredient by 2. And I would only need 1 muffin pan. I can make more cupcakes by doubling the amount of each ingredient. How many muffin pans would I need now?

You might want to make a layer cake with this recipe. That works! But you would change the amount of time to bake the batter. Once you have a good basic recipe, you can do all kinds of things with it . . . if you know your math!

Exact Science?

What happens if you don't follow the baking measurements exactly? You may notice a difference in the taste and texture. Each ingredient, in its specific amount, gives a cupcake its flavor and feel. Chefs experiment with measurements as they come up with recipes.

Baking is a wonderful blend of math, science, and art. By understanding measurements and fractions, you can create delicious treats. I promise you that these cupcakes are as tasty as they look!

This is Chef Nadia wishing you a sweet, delicious day!

Until next time, happy baking!

Main Idea

We use math skills when we bake.

The Mural Makers

Chapter 10

One sunny morning, Marcus, Nora, Max, and Yami meet at the local community center. They have been invited by their art teacher to paint a big mural on the wall that leads to the main entrance of the after-school facility. The wall is plain and needs some bright colors. The friends want to make it beautiful for everyone who comes to the center.

First, they stand back and look at the big wall. It is like a giant white canvas waiting for their creative ideas. They talk about planning what they want to paint. Each student has a different idea of what they want to paint.

But before they start painting, they need to decide how to divide the wall so everyone has enough room to work. They think about dividing the wall into 4 equal parts, one for each of them. But then, they come up with a better idea.

"Why don't we divide the wall into 8 equal parts instead?" suggests Nora. "That way, we can each paint 2 sections and show more of our ideas!"

Everyone likes this idea.

Equal Parts

Why is it important for the friends to make sure the 8 parts of the mural wall are an equal size?

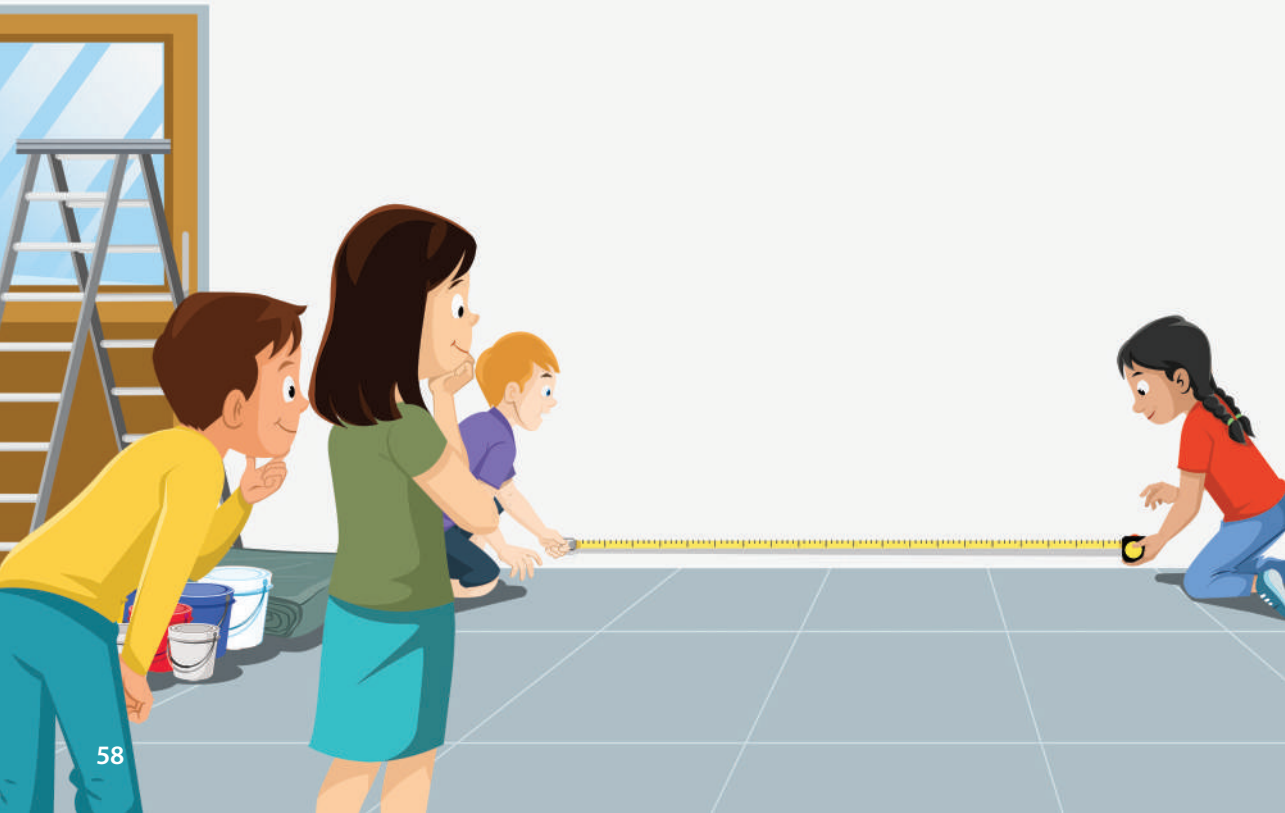
Their art teacher offers to help them set up the wall, but the friends want to try it out themselves. They grab a measuring tape from the tool closet. Yami holds the end of the tape measure with the case near one end of the wall. Max takes the other end and walks toward the other end of the wall. Once he has reached the end of the empty space on the wall, Max stops moving. Yami reads the measuring tape and calls out, "That's 16 feet. Let's mark the ends here!"

Marcus says, "Now what? How do we make the sections equal?"

"There are four of us, so we divide 16 by 4," says Yami.

"But we are each getting 2 sections, remember?" Max says.

"Oh, yeah!" Yami says excitedly. "We divide 16 by 8. Each section will be 2 feet wide." They mark the wall into equal sections, and each friend chooses 2 sections next to each other.



Now they are ready to start painting, but there is one more thing to decide. Should the mural be all about one theme, or should they paint different things in each section? They talk it over while they set out their paints and brushes.

"I think we should each paint something different," Marcus says. "That way, we can show off what each of us loves the most!"

"I agree," Yami adds. "It will be like a patchwork quilt. Each part will be unique, but together, it will look amazing!"

Nora and Max nod. They all love the idea of combining their favorite things into one big, colorful mural. So they decide to go ahead with different themes.

Soon, they are each busily painting in their sections. Even after measuring and dividing the wall, the friends' excitement takes over. They ask each other if it is all right to share sections. Soon they are creating one big scene that shows all of their ideas together.

As they paint, people from the community stop by to watch. Everyone is impressed by their teamwork and creativity.

By the end of the day, the mural is finished. It is bright and colorful and has something for everyone. The friends step back and proudly examine their work.

"I'm glad we adjusted our plan and moved into each other's sections," says Max.

"Yes, I can still see the lines for each of our sections," says Yami, "but we shared the space, just like people in this community center do."

Main Idea

We can divide a whole into equal parts.

Love, Tennis

Chapter 11

Have you ever played tennis or watched others play it? Maybe you have wondered what all the different lines mean on a tennis court. Or maybe you heard someone say "15–Love," and you weren't quite sure what that meant. Let's learn about tennis!

Tennis is a racket sport, which means a racket is used to hit a ball. Players play on a rectangular court and hit the ball back and forth over a net. The ball can only bounce one time before a player must hit it. The goal is to hit the ball so that the other player (or pair of players) is unable to return it inside the edges of the court. Players win a point when their opponent fails to return the ball successfully.

Tennis for Everyone

Tennis can be played individually, in what is called “singles.” Or it can be played in pairs, which is called “doubles.”

It can be played by people who use wheelchairs, too. The rules for wheelchair tennis are a little different. Players can let the ball bounce twice before they hit it back over the net.

Tennis Court Basics

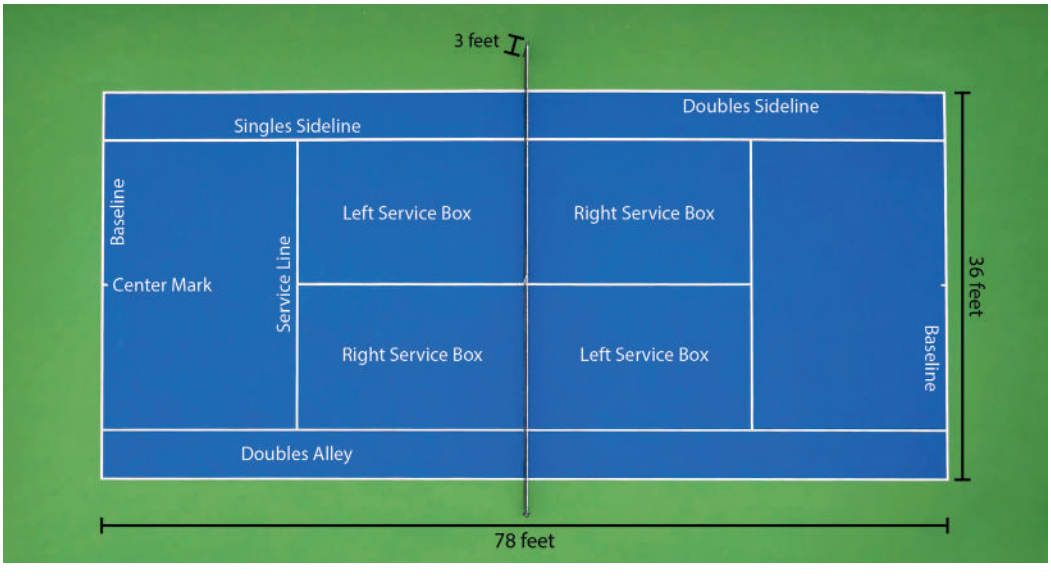
A tennis court is a rectangular area of grass, clay, or other material. It can be outside or inside. A net divides the court into 2 halves.

The court is marked with lines. Some lines show the edges, or boundaries, of the court. The baselines are at each end of the court. There are also sidelines along the sides of the court. Singles and doubles games have different sidelines. The doubles sideline is about 4 feet outside the singles sideline.

Within the playing area is a service box. It is a large rectangle on both sides of the net. A line called the center service line divides this rectangle in half. This forms two boxes called service boxes. From an overhead view, you can see that the combination of the net and the center service line forms a rectangle divided into half and then half again.

Tennis Fractions

The net and center service line divide the rectangle into fourths. It's similar to the way you might fold a piece of paper in half and then in half again to make four equal parts.



Game Scoring

To win a game, a player must score at least 4 points. They must also be ahead by at least 2 points. The points within a game have unusual values or names!

Points	Name
0 points	Love
1 point	15
2 points	30
3 points	40

Easy peasy, right? But it gets tricky. If the score becomes 40–40, it is called deuce. Then, a player has to win 2 points in a row to win the game.

If a player wins 1 point from deuce, they have advantage. If they win the next point, they win the game. If they lose the next point, the score returns to deuce.

Game, Set, Match

In tennis, players play several games in a row, called a set. And they play several sets in a row to make up a match.

A set consists of at least 6 games. But they also can be longer than that! That's because a player has to be ahead by at least 2 games in order to win the set. So a player cannot win a set if they have won 6 games but their opponent has won 5 games. They have to keep playing!

If both players have won 6 games, the players are tied. Another game, called a tiebreaker, has to be played to see who wins the set. In a tiebreaker, a player wins by scoring at least 7 points and also being ahead by 2 points!

Keeping Track

Why is it hard to win a tiebreaker set? What scores might someone need to win a tiebreaker?

Matches can be made up of 3 or 5 sets. To win a best-of-3 match, a player must win 2 sets. To win a best-of-5 match, a player must win 3 sets.

Try Tennis!

All the rules and new words might be challenging at first. But once you know the basics, tennis is a fun and exciting game to play! Many parks have tennis courts, so all you need is a couple of rackets, a ball, and a friend, and you can get started. It's a great way to get some exercise for your body. And your mind gets exercise, too, as you keep track of points, sets, and matches!

Main Idea

Fractions and counting strategies help with understanding and playing tennis.

A Bigger Burger?

Chapter 12

In the heart of the city's bustling food scene, a fierce competition is going on!

The competition is between 2 beloved burger places, Best Burger and Greta's Grill. They have been in a years-long struggle to answer one of life's most important questions:

Whose burger is better?

Both restaurants have been known for their yummy $\frac{1}{4}$ pound burgers. Both have built up a loyal following of burger lovers. In the past, advertising has been about the shape of the burgers and the toppings. Ads have described the freshness of the ingredients.

However, one chain has now taken a new step. It has dared to go bigger.

In a bold move aimed at attracting customers by offering larger burgers, Greta's Grill announces the introduction of $\frac{1}{3}$ pound burgers. The move is met with excitement from some customers. They are eager to sink their teeth into a larger burger.

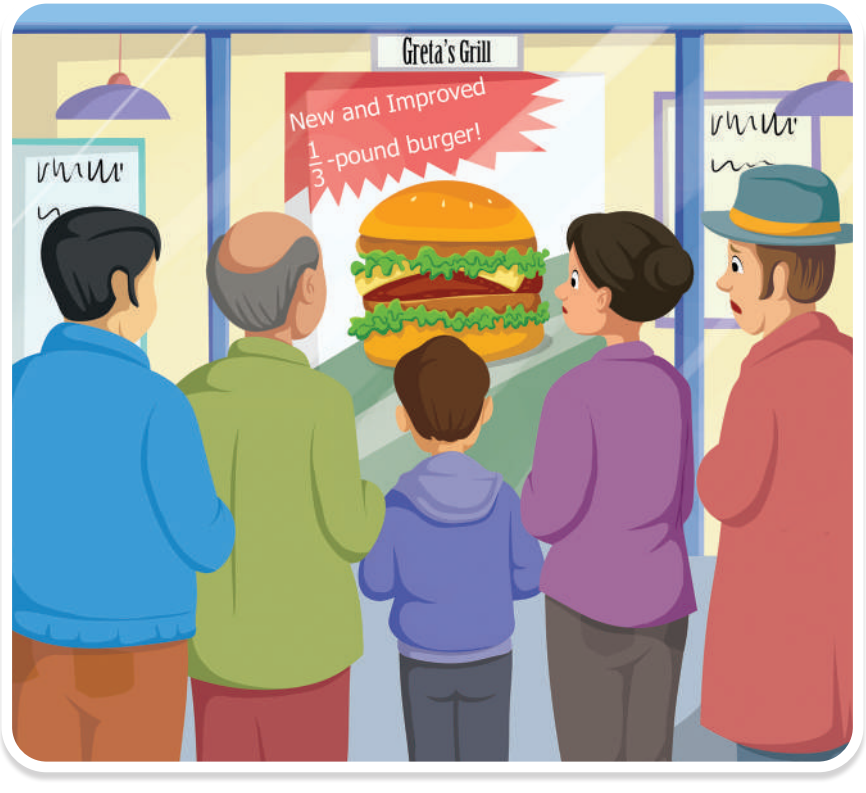
However, other customers are confused. Some are annoyed. They don't fully understand the change from $\frac{1}{4}$ of a pound to $\frac{1}{3}$ of a pound.

"It just doesn't make sense," remarks one confused customer. "Why would I want a smaller burger?"

Burger Panic

Why are some customers upset that Greta's Grill is switching to a $\frac{1}{3}$ pound burger?

The reason for switching from $\frac{1}{4}$ pound to $\frac{1}{3}$ pound burgers has been tricky to communicate to the hungry public. It has proven to be trouble for Greta's Grill. The restaurant workers have to explain that the denominator, or bottom number in a fraction, tells how many parts are in the pound of hamburger. Cutting a pound evenly into 3 parts produces bigger parts than cutting a pound into 4 parts. Signs are printed that show the increase in size. Yet sales of the new burgers are disappointing.



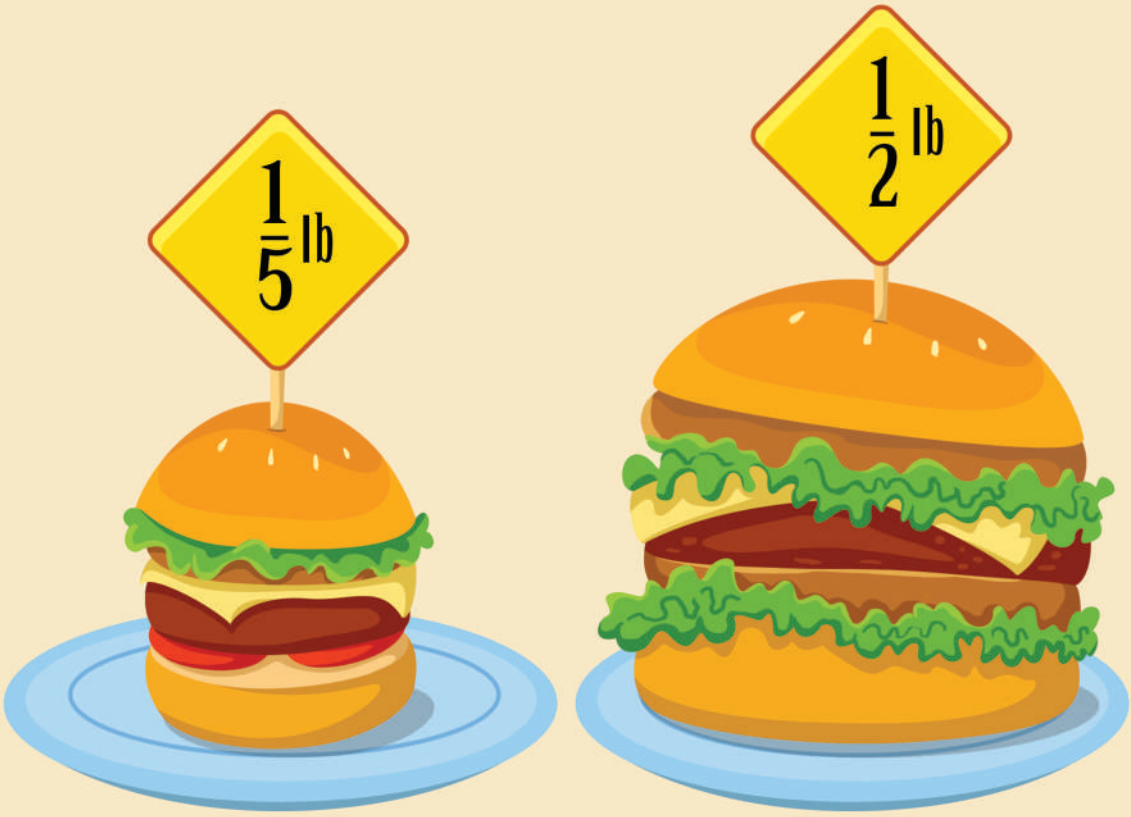
On the other hand, Best Burger continues to thrive with its tried-and-true $\frac{1}{4}$ pound burgers. "We've built our reputation on this burger," states the owner of Best Burger. "Our customers know exactly what they're getting. The burger is just the same every time. We stand by our $\frac{1}{4}$ pound burger!"

Both Best Burger and Greta's Grill are confident their burgers are the finest. And Greta's Grill hasn't given up its new $\frac{1}{3}$ pound burgers. Instead, it is hoping to educate people on the larger size of its burger. In time, it believes people will understand that $\frac{1}{3}$ is a larger fraction than $\frac{1}{4}$.

"Once people see that our burgers are actually larger, they will flock to get them!" says Greta Smith, owner of Greta's Grill.

Will hungry customers warm up to the idea of a $\frac{1}{3}$ pound burger. Or will the classic $\frac{1}{4}$ pound burger win the day?

As the battle continues, burger lovers can learn a few things about burger sizes. Because who knows—what if someone comes out with a $\frac{1}{2}$ pound burger or a $\frac{1}{5}$ pound burger? Burger lovers need to be ready to know which burger is truly bigger!

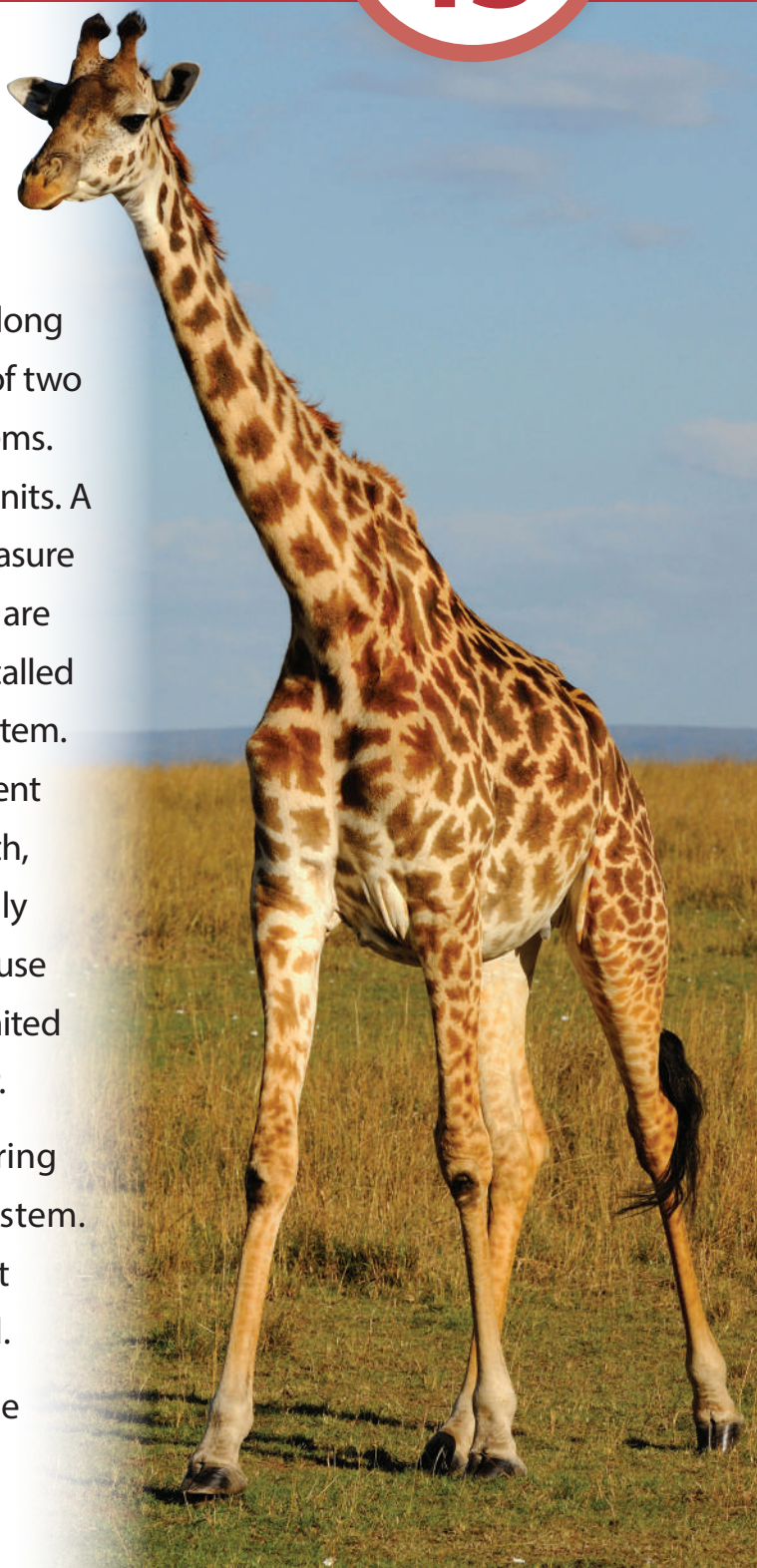


Main Idea

When the bottom number in a fraction is bigger, the whole is divided into more parts, so the parts are smaller.

Measuring Up with the Metric System

Chapter 13



Is a giraffe 17 feet tall? Or is it about 5 meters tall?

Actually both are correct!

Both feet and meters are used to measure how tall or long something is. They are part of two different measurement systems. All systems are made up of units. A unit is a an agreed-upon measure that is always the same. Feet are part of a measuring system called the standard, or imperial, system. A foot is a unit of measurement that is always the same length, no matter where you are. Only a few countries in the world use this system, including the United States, Liberia, and Myanmar.

Meters are part of a measuring system called the metric system. This system is used by most countries around the world.

Let's take a closer look at the metric system!

To understand how the metric system came to be, we need to go back to the beginning. Before the 1700s, every country had its own measuring system. Even different parts of the same country could have their own measuring system! Can you see how that might make buying and selling things difficult? Say you wanted to sell fabric by length. You would have had to measure your fabric in a different unit in each place. That could get confusing!

In France, there were more than 250,000 different units used for measuring!

Then things changed. In 1789, the French Revolution brought about a new government in France. And this new government saw the confusing measurements as a big problem. It chose a team of scientists to come up with a plan. The scientists were eager to make a measurement system that wasn't based on tradition but on science and math.

The scientists decided to devise a unit to measure length and call it the meter. The meter is based on the distance between the equator and the North Pole. The equator is the imaginary line that runs around Earth's center. The equator is halfway between the North Pole and the South Pole. The distance between the equator and the North Pole is about 10,000,000 meters. One meter, they said, would equal a tiny fraction of this distance. That fraction was one ten-millionth! One meter is about the length of a baseball bat or a guitar.

Then they devised a new unit that they named the liter. The liter is used to measure volume, which is how much space something takes up. For example, a large bottle of soda might contain 2 liters of liquid. They did the same for mass, which is how much matter something has. They also decided to base their entire system on the number 10.

The scientists did the same for mass, which is a measurement of how much matter something has. Sometimes we think of this as how much stuff is in something. A bowling ball and a basketball may look to be the same size, but the bowling ball has more mass. A new pencil has a mass of about 5 grams. The new French metric system could be used for all 3 basic units of measure—the meter, the liter, and the gram.

But this isn't all the scientists did! They wanted to make using the metric system as easy as possible. For example, instead of having to learn many different words to measure length, such as *inch*, *foot*, *yard*, and *mile*, they decided to use the base word *meter* and add prefixes to make larger and smaller measurements. A prefix is a word part that you add to the beginning of another word to change its meaning. You may have heard of words like *centimeter* and *kilometer*. These are all units that measure length in the metric system.

Each unit of measure has an abbreviation. A lowercase *m* is used for *meter*. A capital *L* is used for *liter,* and a lowercase *g* is used for *gram*.

The scientists wanted the metric system to be based on 10, so they made each prefix relate to either dividing or multiplying based on the number 10. The hardest part of the metric system is learning the prefixes. But once you do, the same prefixes are used in volume and mass as well!

What other things do we use based on the number 10? Money! One dollar could be represented by 1 dollar bill or 10 dimes or 100 pennies.

Making Sense of It All

You can use the prefixes and their meanings to understand measurements. A milliliter is one thousandth of a liter. That means there are 1,000 milliliters in one liter.

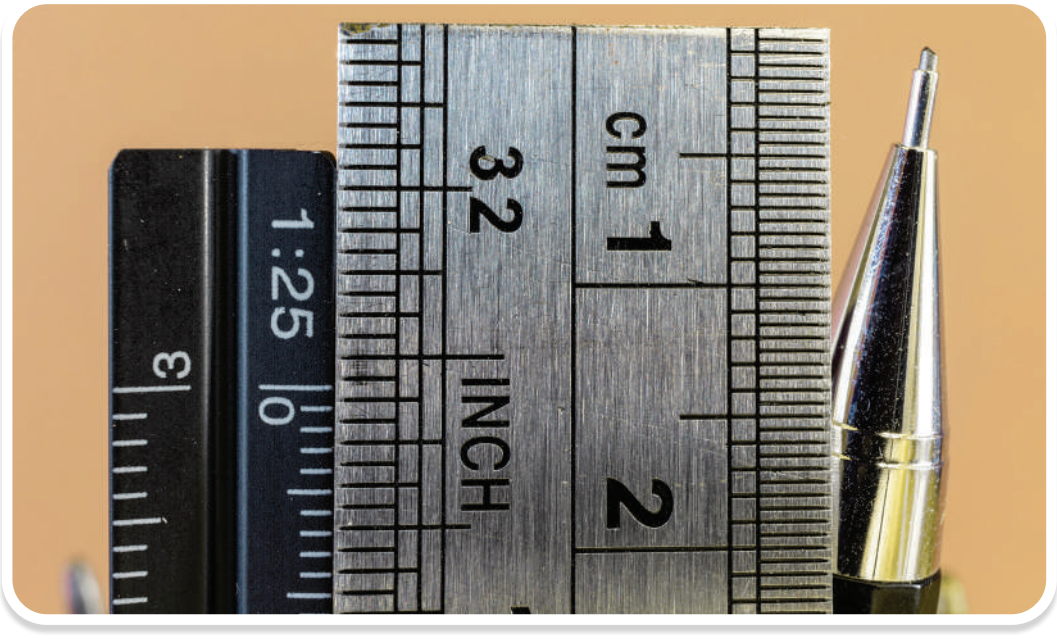
Over time, the metric system spread. Today, you may hear these prefixes used many different ways. A car may travel 120 kilometers per hour on a highway. You may take 5 milliliters of cough medicine when you are sick. The prefixes tell you how large or small each measurement is.

Many cars have speedometers that indicate both miles per hour (MPH) and kilometers per hour (km/h).

The metric system is now the main system for measuring all over the world. Also, scientists in every country use the metric system for scientific data. This ensures that scientists can always better understand each other's results. Even in the United States, which uses a different system, scientists use the metric system.

The metric system has even improved since the French scientists first developed it. For example, in 1983, scientists improved the definition of a meter. They made it more precise by relating it to how fast light can move.

So the next time you see measurements in meters, liters, or grams, remember that they're part of the metric system, where everything is linked by the number 10.



Main Idea

The metric system of measurement is based on the number 10 and is used in most places throughout the world.

And the Survey Says . . .

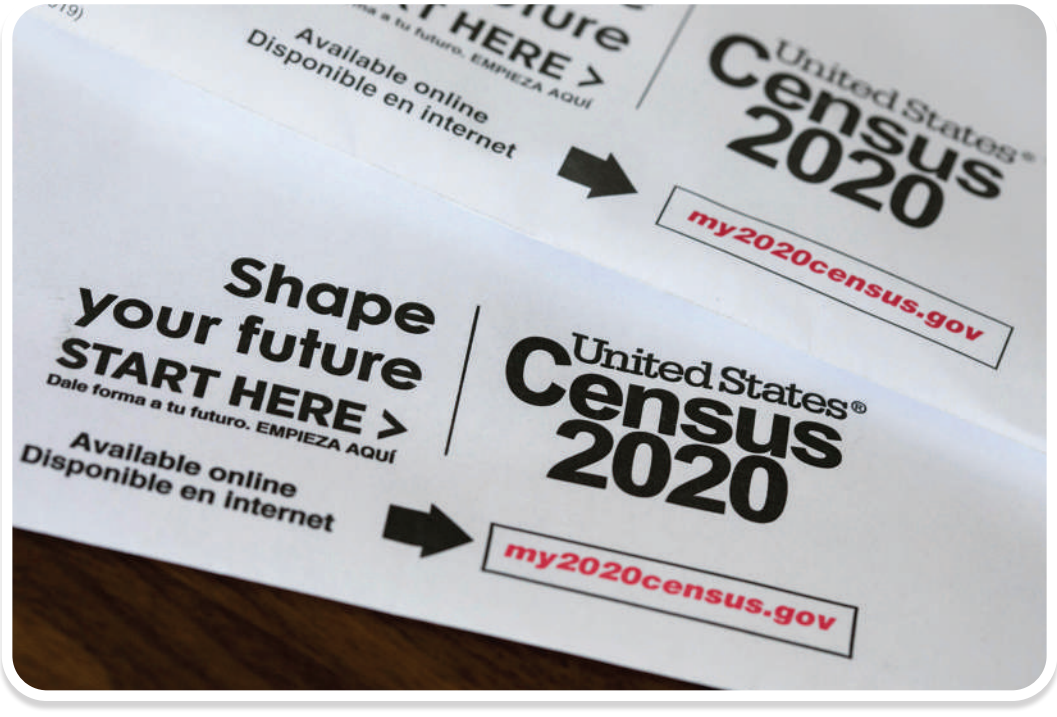
Chapter 14

How can you find out if your favorite ice cream flavor is popular around the world? One way is to use math and do a survey!

A survey is a way to gather information. It is made up of questions. Sometimes a survey goes out to a large number of people chosen at random, asking them what they think about something. Once everyone has answered, the answers are counted, the data are studied, and the results are often published.

A survey about ice cream might ask a large number of people to choose their favorite flavor among chocolate, vanilla, and strawberry. If most people answered "chocolate," you could say that chocolate was the most popular flavor, or what most people prefer. (In fact, many surveys have revealed that the largest number of people around the world prefer vanilla!)

One type of survey is a census. A census is conducted by the government. A census asks questions such as how many people live in a household and how old they are. The purpose of the census is to know how many people are in a certain area to better distribute resources and to make plans to prepare for the future population. Though most countries conduct a census periodically, in the United States, it is required by the Constitution.



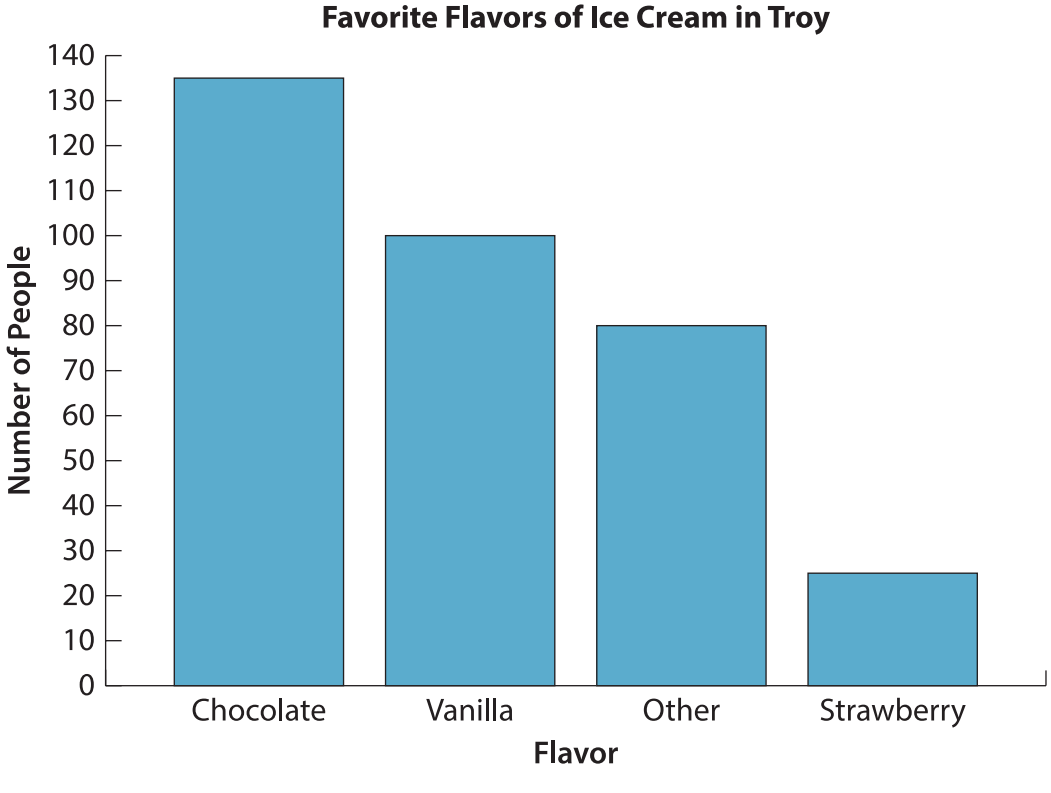
Government use of different surveys became more widespread during the 1800s. Governments wanted to know what people thought about different issues. For example, in 1935, U.S. president Franklin D. Roosevelt wanted to know people's opinions about government programs meant to help them during the Great Depression. So the government conducted a survey.

Companies also use surveys to find out what people think of their products. In 1950, the Nielsen company began doing surveys to find out people's favorite television shows. The Pew Research Center is another famous survey company. It began doing surveys in the 1990s. At first, it focused on questions about politics. But over the years, it expanded to surveys about many other topics, such as technology use and religion.

Today, surveys are used to collect information about people's opinions on all sorts of topics. Many people complete surveys online.

Once a survey is completed, how can you find out the results? Presenting results is an important part of gathering information. One way to present results is to create graphs. A graph is like a picture that shows information. Graphs make it easier to understand the information. There are many different kinds of graphs, such as bar graphs, pictographs, and circle graphs.

Bar graphs show information using bars of different lengths. Each bar represents something, like the number of people who chose chocolate as their favorite flavor. The taller the bar, the more people chose that flavor. The graph below represents a survey taken in a small town called Troy. These results are different from the worldwide survey. Can you identify the most popular and least popular flavor?



A pictograph is another way to show data. It gets its name because it uses pictures to represent how many people make each choice. The scale on a pictograph tells you how many people each picture represents. A small survey might have a scale that shows each picture stands for 1 person. A very large survey might have a scale that shows each picture equals 100 people! You can find the scale by looking for a box called a key.

In this pictograph, the scale tells us that 1 picture of an ice cream cone stands for 10 people. The flavor with the most pictures is the flavor chosen by the greatest number of people—or the most popular.

Dare to Compare

How is the pictograph similar to and different from the bar graph on page 83, which represents the same information?

Favorite Flavors of Ice Cream in Troy

Chocolate	
Vanilla	
Other	
Strawberry	

Key  = 10 People

Today, there are over 8 billion people on the planet. Surveys might involve many thousands of people. That gives us a lot of information. So being able to create graphs and other clear ways to show the information is important.

Surveys help us understand what people want, what they like, and how they feel. What kind of survey would you create if you had the chance?

Main Idea

A survey is a tool for gathering information from groups of people, and the information can be displayed in different ways.

Ticking Through Time

Chapter 15

You wake up at 7:00 every morning. You plan to go to a movie at 3:20 this afternoon. You have events planned all day long. You'd better have a way to tell the time!

Today, people use clocks and watches to know what time it is. They might even see the time on their phone, tablet, or computer.

Before people had clocks and watches, they relied on the natural world to understand time. Ancient civilizations, such as the Egyptians, saw certain patterns in nature. They kept track of where the sun was in the sky during the day. They tracked the seasons and the phases of the moon.

They used these patterns to create calendars. The calendars helped them know when to do important things, such as plant crops or get ready for winter.

Moon phases

Sundials and Water Clocks

Calendars helped people keep track of times of the year. However, calendars couldn't help keep track of time during a day and night. So people invented timekeeping devices for that purpose. One of the earliest was the sundial. On a sundial, a stick in the center casts a shadow that falls on the sundial's face. As the sun changes position in the sky, shadows change direction. The shadow on the sundial points to the time of day.

People couldn't use a sundial at night, so water clocks were invented. Water would drip through a small hole from one container to another. People measured the hours by how much water had dripped.

Ancient Egyptians first divided a day into 24 hours. Another ancient people known as the Babylonians decided to divide every hour into 60 minutes and every minute into 60 seconds. The time system we use today combines ideas from both the ancient Egyptians and the ancient Babylonians.

Sundial

Mechanical Clocks

As societies became more advanced, people wanted more precise ways to tell time. Mechanical clocks had gears inside, which turned the hands on the clock face. The hands showed the passage of minutes and hours. Early mechanical clocks used a weight to turn the gears. As the weight fell, it pulled on the gears and turned them. Later clocks used a swinging weight, called a pendulum, to move the hands on the clock.

A clock that uses weights and a pendulum

A clock that uses a pendulum

Smaller and Better

Over time, clocks got smaller and better. Small clocks that fit in a pocket, called pocket watches allowed people to tell time wherever they went.

After the pocket watch came the wristwatch. The first wristwatches had springs inside. You had to wind them up to keep them working. In the 1950s, watches began to run on batteries. Today, we have even more accurate devices to tell time, like digital clocks in smartphones and many electronic devices. These computer clocks can measure time to within fractions of a second!

A pocket watch

A smartwatch

Ready . . . Set . . . GO!

A stopwatch is a tool that tracks time. It starts counting when you press a button and stops when you press it again. Some stopwatches use moving hands, like a clock. The hand on the large dial tracks seconds. The hand on the smaller dial tracks minutes. Pressing the top button starts and stops the stopwatch. Pressing again resets the timer.

A stopwatch

Going Digital

A digital stopwatch

Many people now use digital stopwatches. These tools are more accurate at tracking time. This stopwatch reads 4 hours, 0 minutes, and 4 seconds. To start and stop the timer, you press the button on the right. The button on the left tells how much faster one time period was than another. The mode button changes the display to time, date, countdown, or alarm. Some stopwatches can even recall times from previous races!

Time Zones

The way we use time has also changed since ancient times. Modern society places a lot of importance on being on time. We want school to start and end at just the right time. We want trains and planes to run on schedule.

In fact, trains led to the development of one interesting part of modern life: time zones. In general, time zones developed because different places on Earth experience sunrise and sunset at different times. So depending on where you are on Earth, it might be midnight or noon or anywhere in between. For a long time, people just called “noon” the time when the sun was highest in the sky. But in a different place, noon would be earlier or later.

This became a problem when trains started traveling across the country. How could people know when the train was supposed to arrive? So the U.S. government decided to create 4 time zones: Eastern, Central, Mountain, and Pacific. Each time zone in the United States is 1 hour later than the time zone to its west. When it is 3:00 in New York, it is 2:00 in Illinois. At that same time, it is 1:00 in Colorado and 12:00 in California.

Timekeeping now is as simple as checking a clock or your watch, but it wasn't always so easy. From ancient sundials to wristwatches, telling time has always been an important part of human civilization. It has shaped how people live their lives and think about the passage of time.

Main Idea

Timekeeping and ways of thinking about time have changed from ancient times to today.

Feline Design

Chapter 16

Harrison and Greyson are excited because they have a new game to play on their TV. It is called *Feline Design*.

When the game starts, Tommy Cat is making plans to update his home. He needs to get ready for the kittens that are about to be born.

The goal of the game is to help Tommy Cat make good decisions on how much material he needs to buy. Harrison and Greyson are excited because this will challenge their math skills. They will get points for how quickly they solve the math challenge in each room. They faster they solve a challenge, the more points they get!

As the game starts, Greyson says, “How fun! This is like when we set up our home for our cat, Pumpkin, when she had kittens!”

The game begins on the screen with Tommy starting work. “Time to get rid of this old carpet! It has been here since I was just a kitten. I’ll need to measure to know how much carpet to get to replace the old carpet.”

The brothers notice all the tools available to use on the game. Harrison says, “Let’s use this measuring tape to have Tommy measure the length and width of the room.”

"Good idea," Greyson replies. Harrison uses the measuring tape tool and has Tommy measure the length from 1 wall to the other wall. "It's exactly 12 feet!" Greyson says. "We need a 12 foot length of carpet, but how wide will the piece of carpet need to be?"

Harrison measures the length between the opposite 2 walls, or the width of the room. Greyson looks at the measuring tape and sees the measurement is 10 feet.

A screen pops up: "How much carpet does Tommy need to buy?"

Harrison says, "We need to multiply the two measurements to find the area of the room. 12 times 10 is 120."

"So Tommy needs 120 square feet of carpet," Greyson says. When Harrison records the area of the room on Tommy's notepad, a screen pops up: "Super! You solved this challenge in 5 minutes! You earned 5 points!"

Feet That Are Square?

A square foot is a measurement used to describe area. It is called a square foot because it is based on the idea that the length and width of the square are each 1 foot.

Another message pops up on the screen: "One-third of the way done!" Greyson says, "What does that mean?" Harrison wonders if it has to do with how many rooms Tommy will remodel for the new kittens. Greyson moves Tommy to the kitchen. Tommy knows that kittens eat a lot when they are young. He wants the kitchen to be ready. A new screen pops up: "Help Tommy measure the length and width of the kitchen."

Harrison chooses the measuring tape tool to make Tommy measure the length. Greyson says, "That's 15 feet. Now measure the width." Harrison uses the measuring tape tool again to make Tommy measure the width of the kitchen. "The width of the kitchen is 12 feet," says Harrison.

A screen pops up: "How much tile should Tommy buy for the kitchen?"

"I know!" says Greyson. "We multiply like with we did in the other room with carpet. Then we can determine how much tile Tommy needs." The brothers figure out that the area of the kitchen is 180 square feet.

Harrison places the measurement on Tommy's notepad, and a screen pops up: "You solved this challenge in 3 minutes! You earned 10 points! You are two-thirds done!" "I wonder what Tommy will measure next," Greyson says.

Harrison moves Tommy to the playroom. "I wonder what Tommy will design for the kittens in this room," says Greyson.

Just then a screen pops up: "Tommy wants to make scratching logs that go around the entire edge of the playroom."

This time Greyson uses the measuring tape tool. Greyson measures 1 wall and comes up with 10 feet. He measures another wall, which is also 10 feet.

"Tommy needs 100 square feet of wood!" exclaims Greyson.

"Not exactly," Harrison explains. "Tommy has to measure each wall. We are finding a different measurement this time. The last 2 rooms we found the area to cover the floors. Now we need to find the distance around the edge of the room."

"I am glad you caught that!" says Greyson. Greyson measures each wall. The length of each wall is 10 feet.

"The playroom is a perfect square," says Greyson.

Another screen pops up: "How much wood does Tommy need for the scratching logs?" At the same time, the brothers say with excitement, "40 feet!"

All the Way Around

A perimeter is the distance around a shape. To find the perimeter, just add up the lengths of all the sides.

Greyson writes the measurement. The brothers know that to find the distance around the room, they add all the wall measurements. But since the playroom is a square, they can multiply 10 feet by 4 to know the distance around the room is 40 feet.

A screen pops up: "You solved this challenge in 3 minutes! You earned 10 points! Now you can help Tommy order his materials from the store."

The brothers look at the measurements on Tommy's notepad. They put in a store order for the carpet, tile, and wood. "We are really good at this. We should remodel our bedrooms!" Greyson says.

"Definitely!" agrees Harrison.

Just as they are finishing up the first part of *Feline Design*, a teaser for the next game shows up on the screen. "Coming this spring: *Designer Dog*!"

Main Idea

Measuring tells how much of the different materials we need for home improvement projects.

Mondrian Art

Chapter 17

If you were going to paint a picture, what would it be? A person? Your pet? A landscape?

How about . . . squares and rectangles?

It might sound unusual, but Piet Mondrian was a Dutch artist who famously painted squares and rectangles!

Piet Mondrian was born in the Netherlands in 1872. He began to study drawing when he was 14 years old. As he got older, he began taking painting lessons.

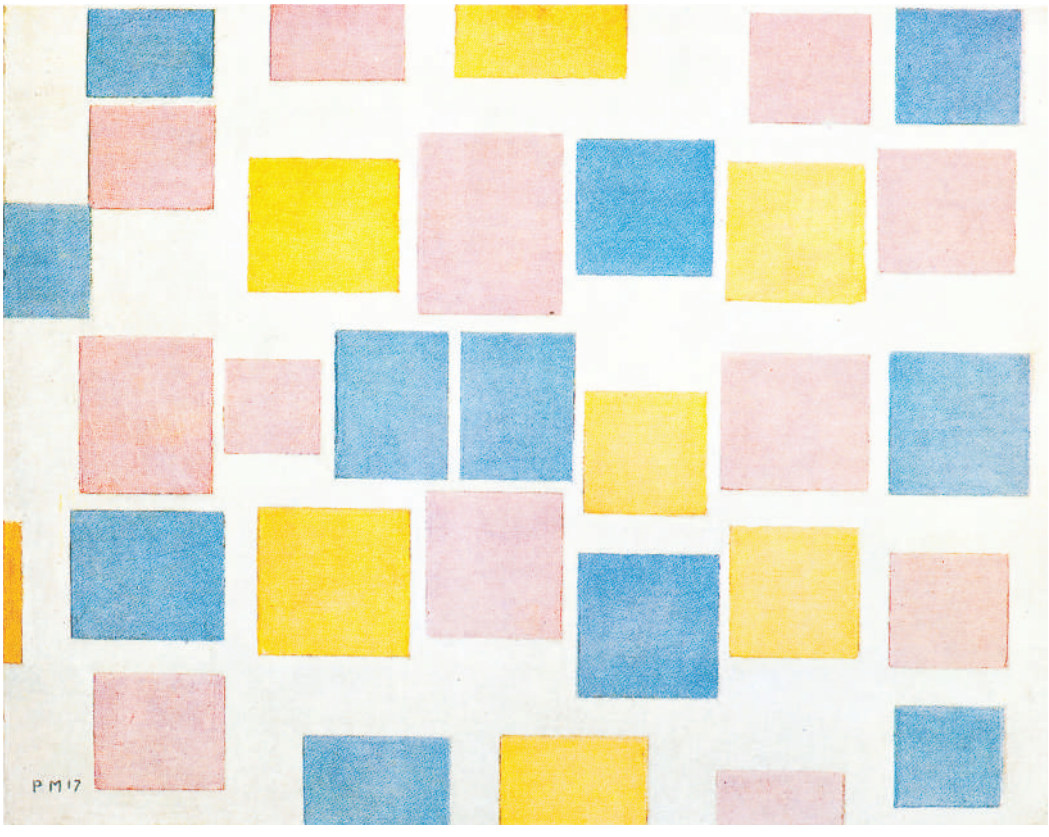
At first, Mondrian's art showed real places and objects, and the paintings looked realistic. For example, one painting shows a farmhouse near a river. Another shows a windmill.

Post Mill at Heeswijk

But as Mondrian grew older, his style changed. He no longer wanted to show nature or real objects in his paintings. Instead, his art became more and more abstract. *Abstract* means his paintings didn't look like real objects or places anymore. Instead, they were all about shapes, colors, and lines working together.

Eventually, Mondrian became interested in using the simplest of shapes to create paintings. He developed a new style based on this idea.

Many of Mondrian's abstract paintings were made up of squares and rectangles in the primary colors—red, yellow, and blue. He didn't always use lines to separate his shapes. Sometimes he left space between them.



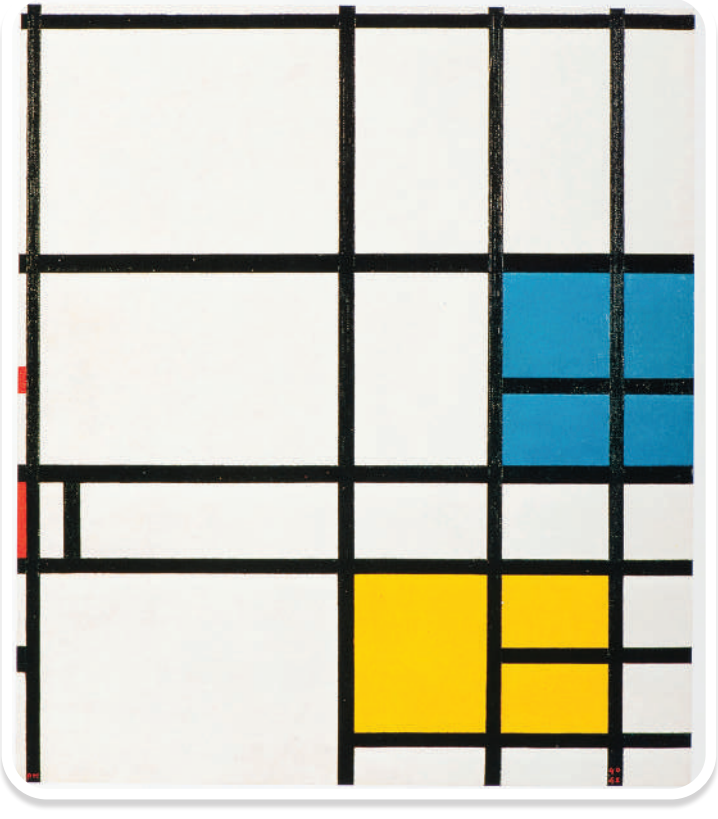
***Composition with Color Planes*, 1917**

Many of Mondrian's paintings include thick black lines. Vertical lines run top to bottom. Horizontal lines run from side to side. These lines form squares and rectangles. Some of these squares and rectangles are painted red, blue, or yellow. Others are white.

It sounds simple! But Mondrian was able to create many different paintings using just these basic forms. He varied the distance between the lines to make rectangles of different sizes. He filled in a few rectangles with color on some paintings. He added more color to other paintings. He created unique artwork just by changing where the lines were and how much color was used.

Color + Geometry = Art

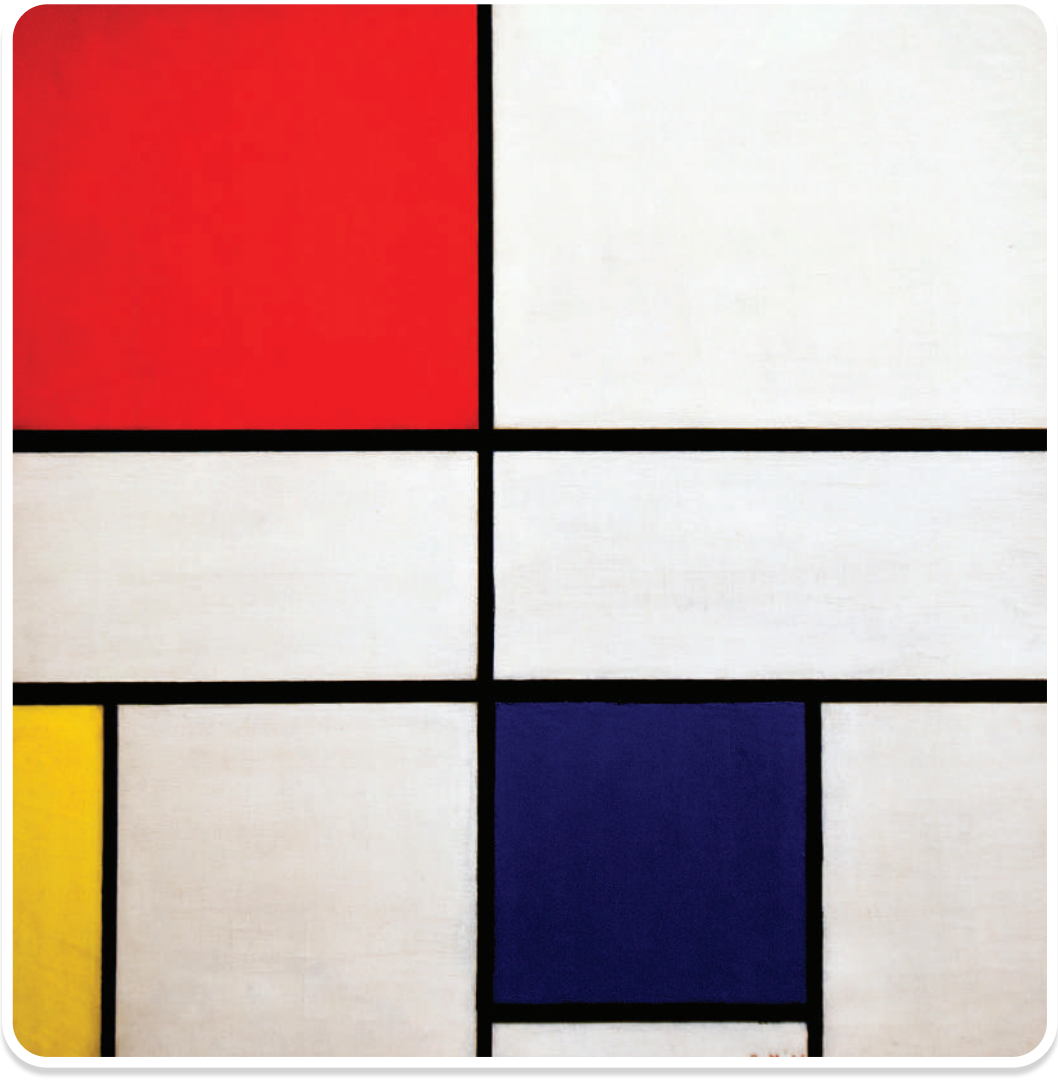
How are the yellow and blue shapes in this painting different from each other? What reason do you think the artist might have had for making them different?



Composition London

Even though his art was simple, Mondrian spent a lot of time making it just right. He kept working on his paintings until they felt perfect to him. He wanted his paintings to express his way of seeing the universe.

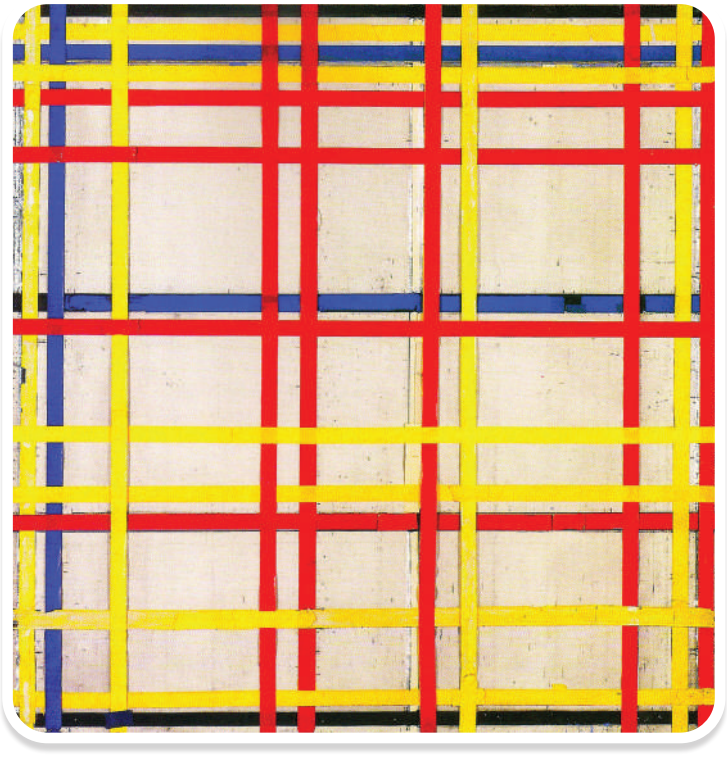
Have you ever thought about how a painting can make you feel? Mondrian's paintings can give people a feeling of balance and harmony. When you look at one of his shape paintings, you might feel calm because of the way the shapes fit together so well.



Composition C (No. III) with Red, Yellow, and Blue

As you can imagine, Mondrian's paintings became very famous all over the world. People loved the way his art made them feel and how it looked so different from other paintings they had seen before.

Piet Mondrian died in 1944, but his art lives on. People today still admire his unique style and use of shapes and colors. And they have sometimes admired his art upside down! In 2022, it was discovered that one of his paintings had been hung upside down for 75 years. The painting is called *New York City I*. It is made up of red, yellow, and blue lines on a white background. It had been shown in several different museums. Each time, it was hung upside down. However, art experts have said that the painting will be harmed if it is hung the right way. So people will have to continue to enjoy the painting upside down!



New York City I

Piet Mondrian, the artist of shapes, showed us that art can be simple yet powerful, using just a few colors and lines to create something truly wonderful. So the next time you see a painting—or a building—with bold lines and colorful shapes, take notice! You might be looking at something inspired by Mondrian!

An apartment building painted in the style of Piet Mondrian

Main Idea

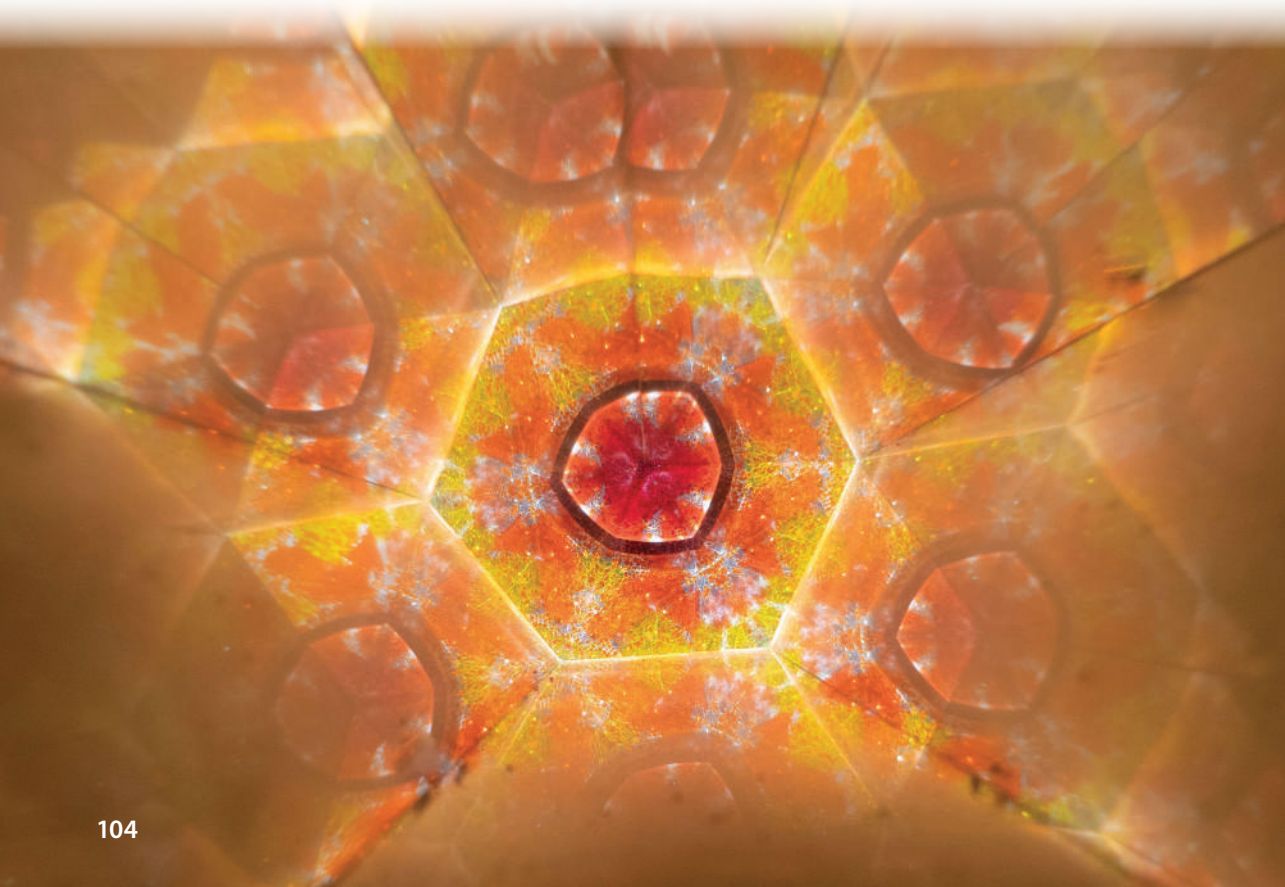
Simple lines and colors can be used to compose art that people find special.

Kaleidoscope

Chapter 18

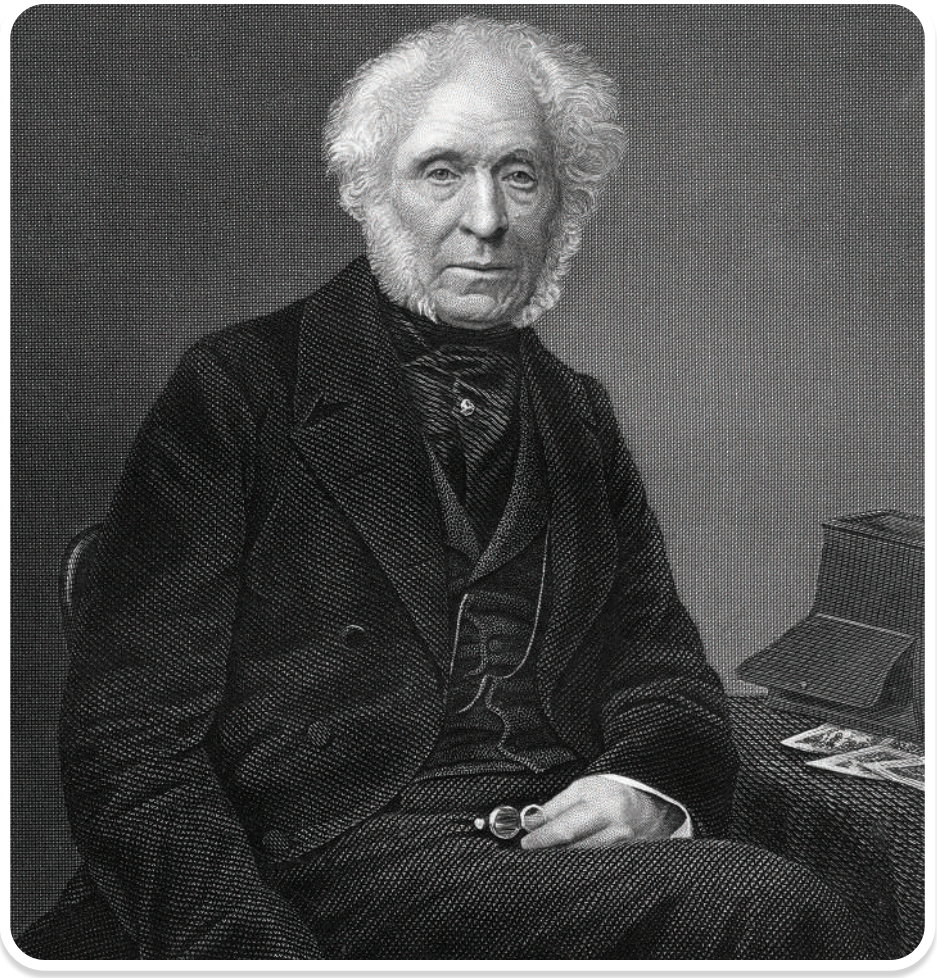
In London in 1816, the invention of the kaleidoscope took the city by storm. It may seem like a simple tube from the outside. But look inside and you will see the most amazing patterns and colors!

The kaleidoscope gets its name from Greek words that mean "beautiful form watcher." It is made of a tube containing shapes made of colored glass and mirrors. To use a kaleidoscope, you look through the tube. The glass pieces and mirrors create the colorful patterns. When you turn the tube, the glass shapes shift and move around inside, causing the patterns to change.



The kaleidoscope was invented by Scottish scientist Sir David Brewster. Brewster came up with its design while researching light. When light hits a mirror, it bounces, or reflects. When mirrors face each other, light reflects back and forth between them.

Brewster was experimenting with mirrors placed together in different ways. He noticed that when he put mirrors facing each other in a V-shape, the reflections formed circular patterns. If he placed objects within the mirrors, the reflection of these objects created an image that demonstrated symmetry. This gave him the idea for the kaleidoscope!



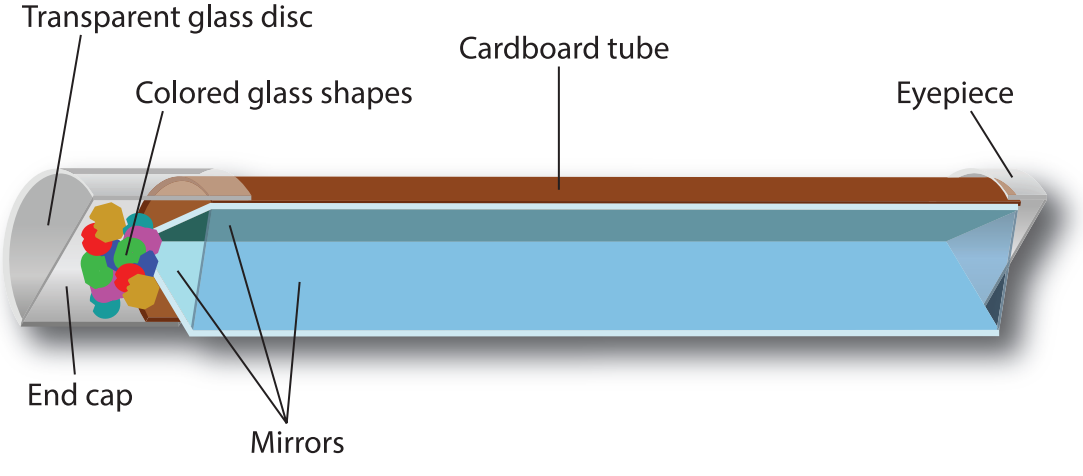
Sir David Brewster, inventor of the kaleidoscope

Soon, Brewster had the idea to place colored glass shapes and other small objects inside a tube with the mirrors. The reflections of these objects inside the tube created unusual shapes. Hexagons, stars, triangles, circles, and rectangles appeared and then shifted, forming new shapes. Rotating the glass shapes in the tube made ever-changing, colorful patterns! These changing patterns seem magical, but they are really demonstrating a mathematical transformation. Brewster found them very enjoyable.

So did many other people! Once people used a kaleidoscope, they loved it. Adults and children all over the city were delighted by kaleidoscopes.

Thanks to the Mirror

Looking into a kaleidoscope, it can be hard to tell which part of the magical pattern is real objects and which part is the mirrors' reflections.



The popularity of the kaleidoscope could not be denied. People from all walks of life carried small, portable kaleidoscopes all over the city. In parks and outside shops, they gathered with others to use and discuss Brewster's invention.

One thing that people especially loved about kaleidoscopes was their ever-changing images. One small movement and the objects inside would tumble into an entirely new pattern—one that had never been seen before. Viewers enjoyed the pattern for a moment. Then they turned the tube, and the old image was replaced by another unique, new pattern. People enjoyed seeing what image would form next. No two images were alike!

Some people worried that people looking into kaleidoscopes might not notice what was going on around them. They feared this would lead to accidents. Others worried that the ever-changing images in a kaleidoscope would cause people to always want new things. They would find everyday life boring compared to the visions inside the kaleidoscope.

However, others saw the kaleidoscope as a good thing. They believed it was a symbol of discovery and creativity. It showed that new inventions could give people new ways of looking at the world. For people who enjoyed both science and art, a kaleidoscope included both! And looking at the patterns was also a playful way to study geometry—math about shapes.

Patterns seen in kaleidoscopes inspired artists and home decorators. Quilt makers got ideas from kaleidoscopes! Quilts are blankets made by sewing together small fabric shapes such as triangles and squares. Kaleidoscopes inspired new, exciting patterns for these colorful blankets.

What might be next? Could walls and floors be decorated with kaleidoscope shapes and colors? Could these patterns be used for stained-glass windows? The possibilities seemed as endless as the images in a kaleidoscope!

Main Idea

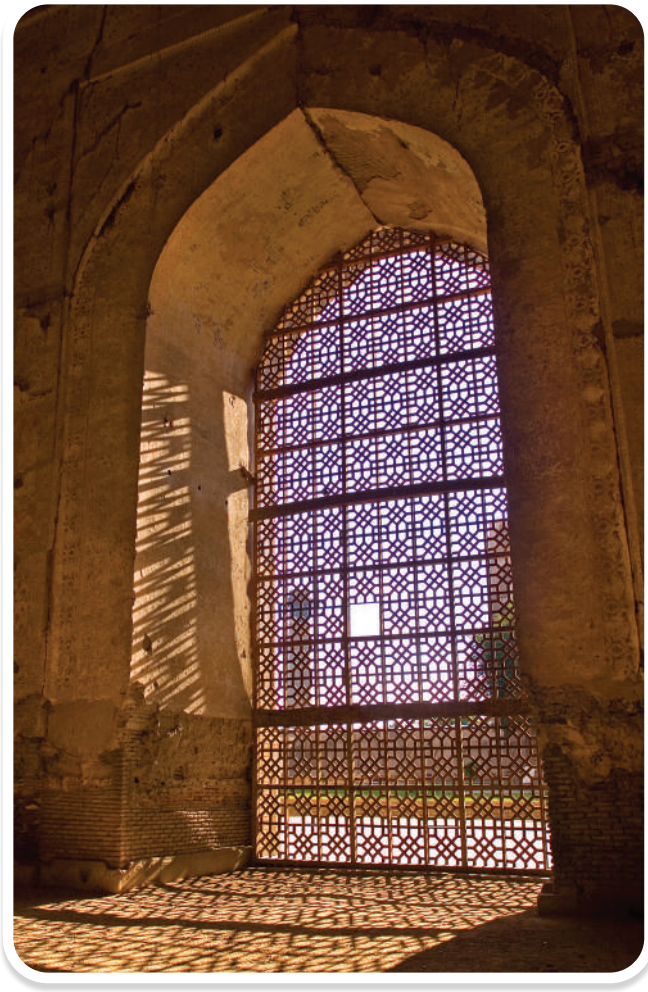
A kaleidoscope uses mirror reflections to make patterns that can be understood through geometry, the math study of shapes.

Geometric Art

Chapter 19

Islamic art is known for its detailed, often colorful geometric patterns. These patterns are made up of shapes such as squares, triangles, circles, and stars. The shapes fit together like puzzle pieces.

The patterns may be carved or painted. They may be on individual tiles put together to cover a wall or ceiling. Sometimes they are used to create beautiful stained-glass windows.



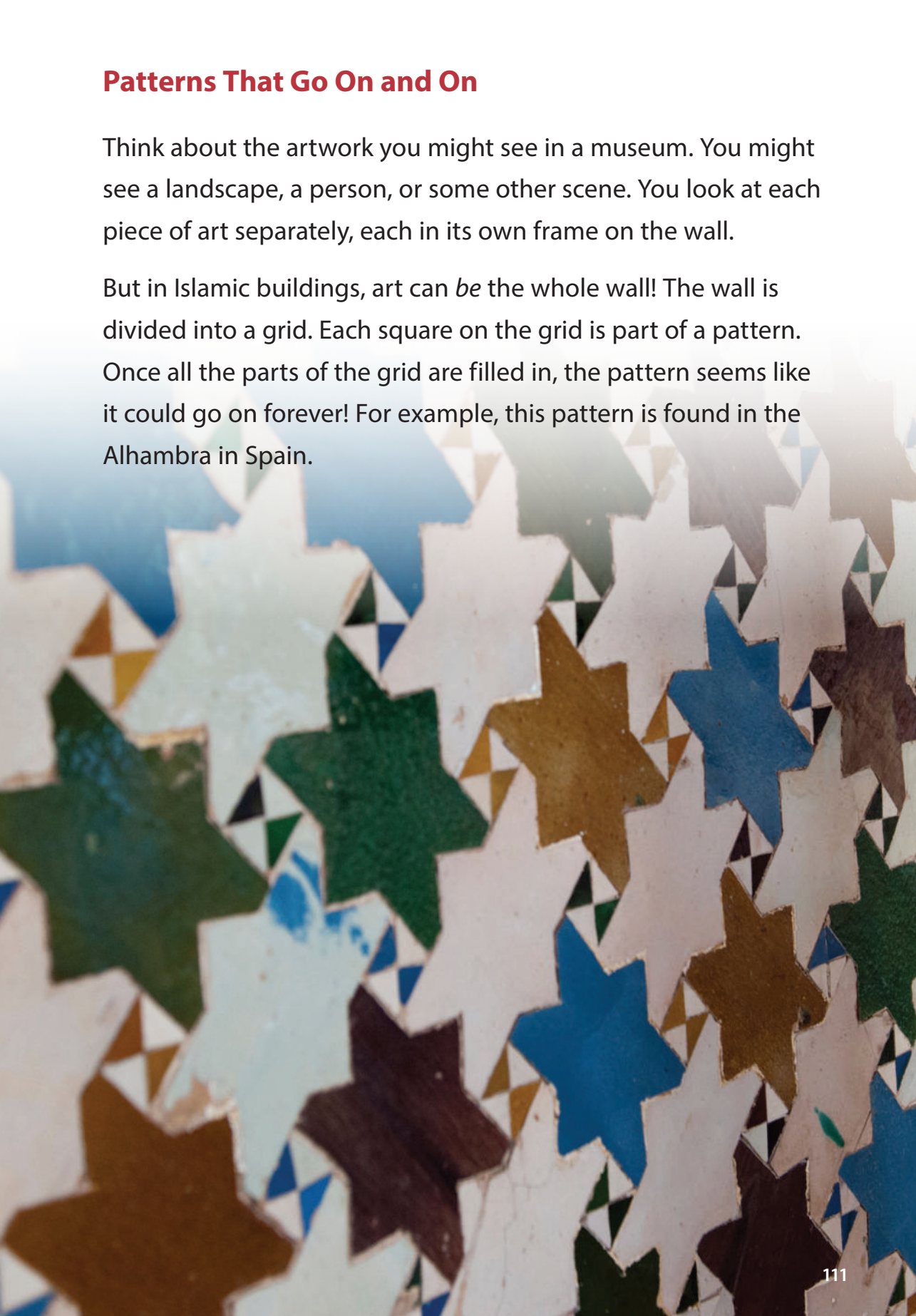
Why do you think these geometric designs are so important in Islamic art?

One reason is that Islamic art avoids showing images of people or animals. Instead, artists use letters and words, basic shapes, and plant shapes. They combine these to create stunning artwork.

Patterns That Go On and On

Think about the artwork you might see in a museum. You might see a landscape, a person, or some other scene. You look at each piece of art separately, each in its own frame on the wall.

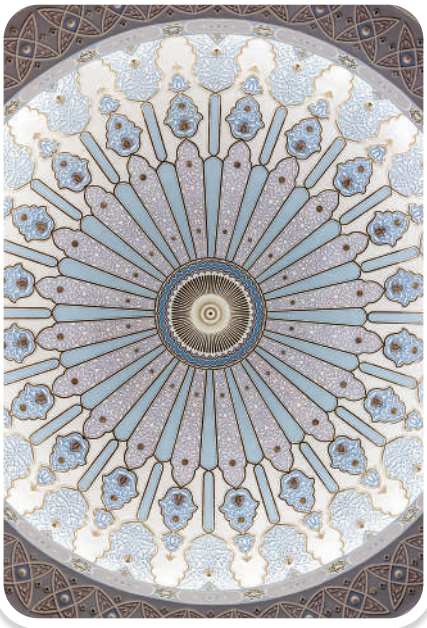
But in Islamic buildings, art can *be* the whole wall! The wall is divided into a grid. Each square on the grid is part of a pattern. Once all the parts of the grid are filled in, the pattern seems like it could go on forever! For example, this pattern is found in the Alhambra in Spain.



Symmetry

Islamic art contains a lot of symmetry. One type of symmetry is when each side of something looks like a reflection of the opposite side. This can be called mirror symmetry. Here's a courtyard at the Alhambra that shows this kind of symmetry. One side of the courtyard looks just like the other. The upside-down building reflected in the pool is a mirror image of the real building.

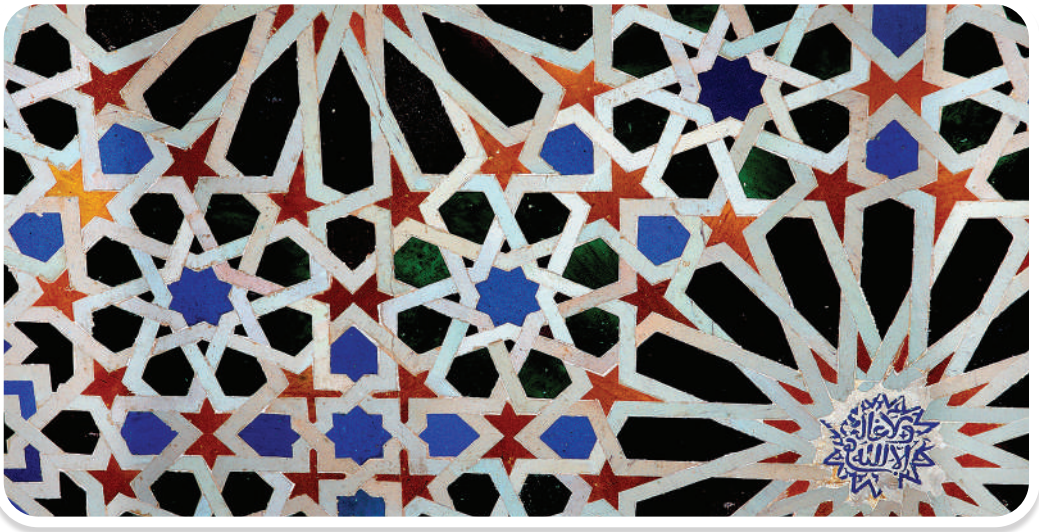
Another type of symmetry is when a pattern forms around a center, like this ceiling dome. This example is from an Islamic art museum in Malaysia.



By using both kinds of symmetry, Islamic artists created unity and order in their work.

Shapes Make Other Shapes

Look closely at some of the patterns in Islamic art, and you will notice that the shapes in the patterns are often made of other shapes. See the blue eight-pointed stars in this tile from the Alhambra? They were formed by stacking 2 squares and rotating 1 of them.



Now look at this pattern from another part of the Alhambra. These stars were made by stacking 2 triangles and rotating one of them!

Shapes from Shapes

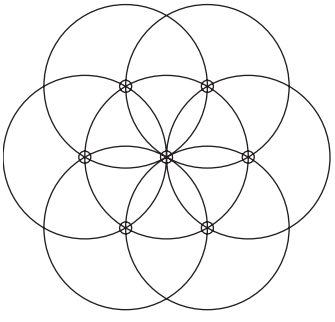
What other shapes do you see in the patterns shown here?

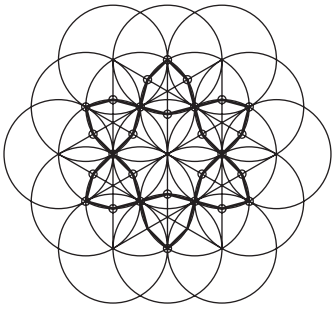
Designing Patterns

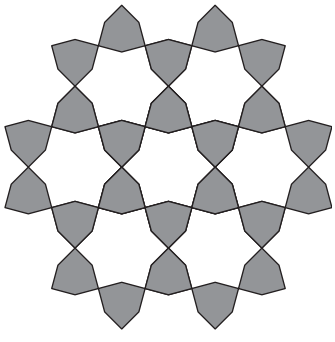
How do people design such detailed patterns? Squares and triangles have straight sides, so it is easy to draw them with any straight-edged tool, like a ruler. You can make different patterns out of these straight-sided shapes.

But what if you want to make a pattern using circles? A drawing compass can help draw perfect circles of different sizes.

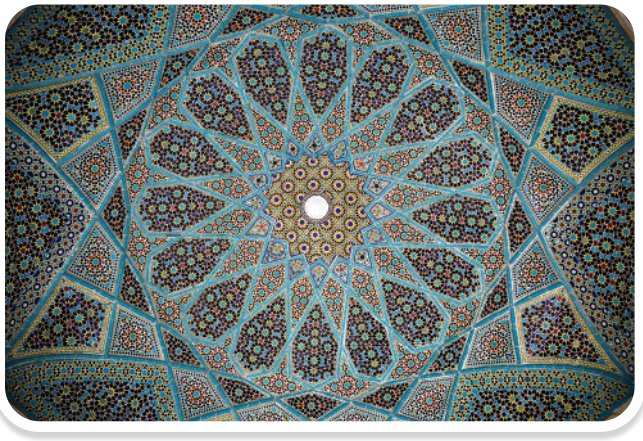
Once you draw a circle, you can make many circles that overlap. Then you can see that all these circles form new, interesting shapes! By shading in some of the shapes, you create a pattern.







All kinds of patterns can be combined to create dazzling decorations. This example is from the Tomb of Hafez, in Iran.



Links to History

The history of Islamic art is connected to the history of mathematics. Islamic scholars made important developments in geometry. One mathematician even wrote about how artists used geometry in their artwork. By studying designs in Islamic art, we can appreciate how art and mathematics are connected.

Main Idea

Islamic art repeats simple shapes to make elaborate geometric patterns.

Amazing Cakes

Chapter 20

This chapter is a transcript. It tells what two people said during a conversation.

Reporter: Hello, everyone! Today, we have the privilege of sitting down with Chef Eric. He's a talented baker known for his beautiful and creative cakes. And his creations include illusion cakes that look like anything but cake! Chef Eric, thank you for joining us.

Chef Eric: My pleasure. Happy to be here!

Reporter: Chef Eric, could you tell us a bit about yourself and how you got into making these amazing cakes?

Chef Eric: Of course! I've always had a love for baking and art. Combining the two seemed like a natural fit. I started experimenting with different cake shapes and decorations when I was a kid. I learned to make heart cakes using just square and round pans. Then I built up to more complicated designs.

Reporter: We've heard that you're particularly skilled in making illusion cakes. Can you explain what those are and how you design them?

Chef Eric: Sure! Illusion cakes are a form of cake art in which the cake looks like some other object—a shoe, a piano, even a hamburger! The challenge is in making the outer layer of the cake appear like the chosen object while still being tasty cake inside. It's difficult but really fun. It is important for these cakes to look realistic.

Reporter: You have to be a little like a sculptor!

Chef Eric: Exactly—except instead of sculpting with stone or metal, I sculpt with cake! Like any artist, I have to see what the basic shapes of something are. For example, a hamburger patty is really just a thin cylinder. The top bun is a dome shape—a bit like a piece of a sphere.

Reporter: Fascinating! Now, let's talk about the structure of your cakes. How do you build your designs?

Chef Eric: Well, it all starts out with very basic 3-dimensional shapes. These are shapes that have length, width, and height. A traditional cake design uses stacked cylinders, which are called tiers. Each tier has 3 layers. So each layer is $\frac{1}{3}$ of its cylinder, or $\frac{1}{3}$ of its tier.

Other cakes are made of cubes or a cylinder on top of a cube. So I always start by creating these main shapes out of layers of cake. I add filling between the layers, of course! If I'm making an illusion cake, I only start carving the final shape once I have built up my layers. Then I cover the entire cake in frosting and decorations!

Reporter: I love hearing about your process! Now, when it comes to serving these cakes, do you have any tips for making sure the pieces are around the same size?

Chef Eric: Oh, definitely. Each cake presents its own challenges when serving it. I actually offer all my customers advice on how to best cut their cake! For a round cake, slicing in wedges is the easiest way. If they cut wedges in a cylindrical cake, they could make equal-sized pieces. Cutting fewer pieces means the pieces will be larger. Cutting more pieces means the pieces will be smaller.

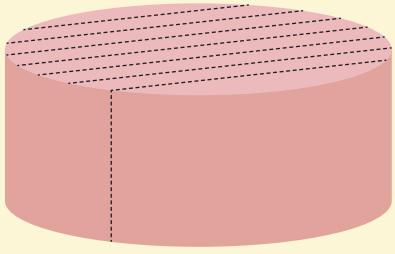
Another way to cut a cake is to slice the cylinder into long slices and then cut those into smaller pieces. However, this method does not create exactly equal pieces. The slices created from the edges of the cake will still have one curved side and be a little bit smaller than the rectangular slices.

I always suggest using a ruler or strip of cardboard with marks on it to guide the cake-cutting process! We also have a "cake-cutting how-to" guide that we give our customers!

One Way to Cut a Cylindrical Cake

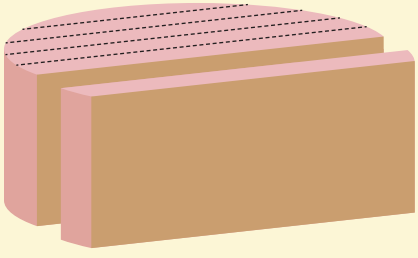
Step 1

Cut one rounded side off the cake and set aside.



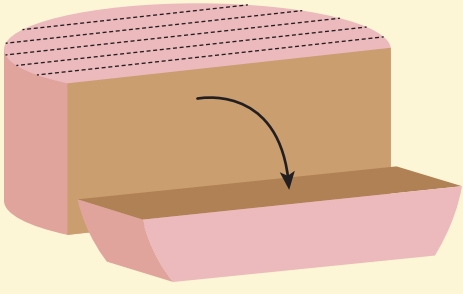
Step 2

Make a second cut to form a long, nearly rectangular slice.



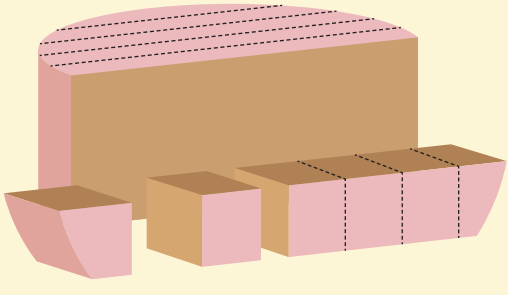
Step 3

Flip the long slice onto its side.



Step 4

Now cut smaller slices. The ends will still have one curved side, so the pieces are not equal in size to those cut from the center of the cake. These end pieces are for people who love frosting!



Reporter: Lastly, Chef Eric, what advice would you give to young bakers who want to get into the world of professional cake making?

Chef Eric: Practice and patience are key. Experiment with different shapes, flavors, and colors. Don't be afraid to take risks and try something unexpected! If your experiment doesn't turn out, you can still learn from it. I've made a lot of failed cakes, but each time I learned something new about cakes, and that's helped me become better. Most importantly, though, have fun!

Reporter: Thank you so much for sharing your ideas with us, Chef Eric. Your cakes truly are a feast for the eyes and the taste buds!

Chef Eric: It was my pleasure. Thank you for having me!

Reporter: There you have it, folks! That was a glimpse into the world of Chef Eric, where cake making becomes an art form filled with creativity and just a touch of math.

Main Idea

Bakers use math skills when they work.

Wild and Free

Chapter 21

Will Dousman, a rancher from central Texas, needs more space for his growing herd of horses. His family's ranch isn't big enough anymore. Will decides to explore a nearby property that is for sale. It is called Anderson Farm. The farm is located in a peaceful valley surrounded by trees.

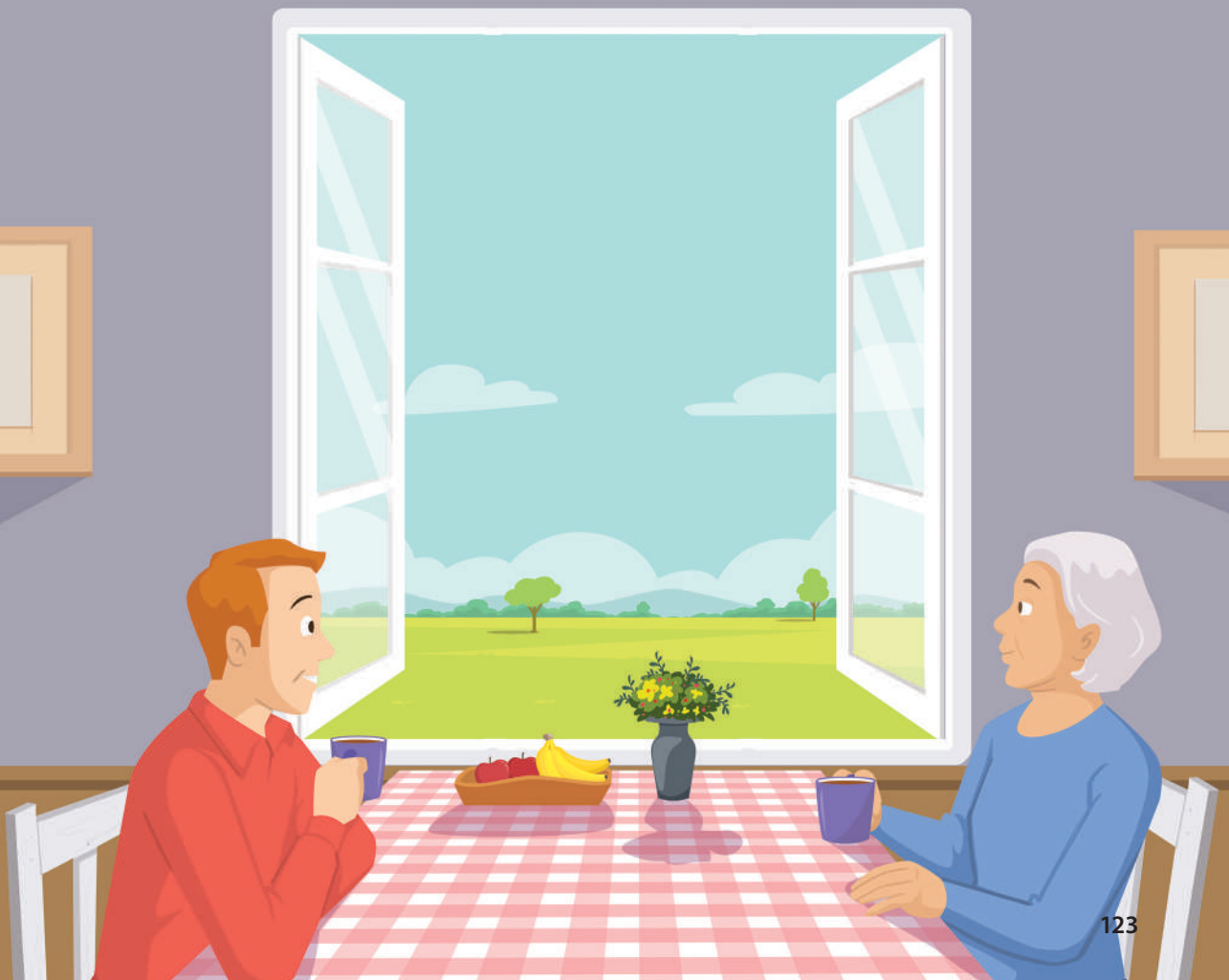
Will rides his favorite horse, Bella, to the Anderson Farm on a cool fall morning. As he rides around the property, he looks around. Will knows that each of his horses needs at least 2 acres of pasture to graze. He estimates that Anderson Farm should have no trouble supporting at least 200 horses. Will only has about 35 horses so far, so the farm would give him plenty of room for more!

Will meets Mrs. Anderson, the owner of Anderson Farm. They discuss the property. Mrs. Anderson shares stories of her family's history on the land. She believes the grassy fields and gentle slopes would be perfect for raising horses, too. She explains that the land used for pasture is enclosed by a sturdy fence.

"Does the fence go all the way around the perimeter of the pasture?" Will asks.

"Yes. It's roughly an L-shape," says Mrs. Anderson. "We fenced in the first part about 30 years ago. The second part was done more recently. I can give you the name of the fence company. They do repairs, too."

"Thanks. That's good to know," replies Will.



The sun begins to set as the two finish talking. Will goes home, feeling excited about the possibility of buying the farm.

Back at his ranch the next day, Will discusses buying Anderson Farm with his family. “It’s big enough that the horses can still feel wild and free. But the fence will keep them safe,” he explains.

After talking over the details, the Dousman family decides to make an offer to buy the farm. Mrs. Anderson accepts their offer, and Anderson Farm becomes part of Dousman Ranch.

With the new property, Will's dream of breeding and raising a large herd of fine horses is coming true. Over time, Will's plans for the horse ranch are put into action. A large barn is built, with stalls that are each 12 feet by 12 feet. Large stalls are important to Will because he wants his horses to be able to turn around and lie down comfortably inside.

Will wants to have both indoor and outdoor areas for exercising and training his horses. He builds an indoor arena for training the horses in bad weather. The arena is a large rectangle, measuring 120 feet long and 70 feet wide.

Will has to consider what kind of flooring to put in the horse arena. He knows he can use sand or rubber. Will worries that sand would be too dusty. So he decides to use rubber made from recycled tires. This flooring doesn't produce dust and will be gentle on his horses' feet. Knowing the size of the arena helps Will to know how much rubber he will need.

Will also builds a large outdoor corral, a square with sides 60 feet long. He builds a fence around the perimeter—240 feet of fencing in all. He covers the ground inside the corral with rock dust, about 6 inches deep. That will keep the area from becoming muddy when it rains.

Will is proud of the progress he makes each day. He knows that success isn't just about acres or horses. It is about taking care of the land and the animals. And for Will, that commitment is a legacy worth working for.

Main Idea

Ranchers use area and perimeter to solve problems at their ranches.

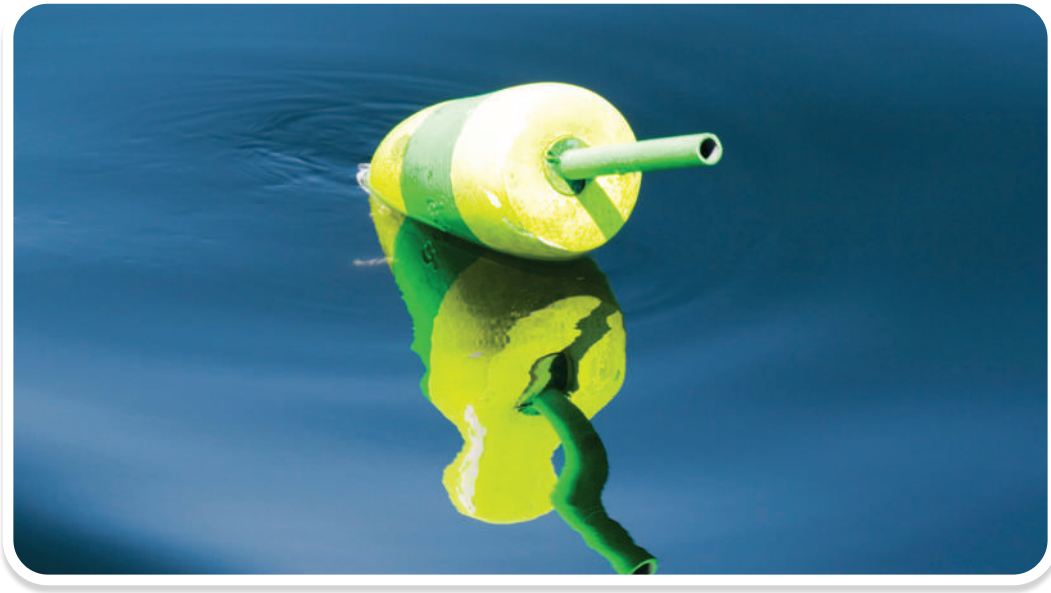
It's a Keeper!

Chapter 22

In the coastal town of Rockport, Maine, Janine Bennett is a successful lobsterman. Every day, she catches lobsters, and she uses quite a bit of math in the process.

Janine spends her days out on the chilly waters of the Atlantic Ocean. Each morning, she wakes well before sunrise. And each morning, she sets out in her boat, the *Sea Breeze*. It is painted bright green and yellow. These are the same colors as the buoys attached to her lobster traps. Each lobster harvesting operation has its own unique colors.

Janine guides the *Sea Breeze* toward her lobster traps. She always has a feeling of pride when they come into view, their green and yellow paint shining in the sun. She pulls up next to them. There, standing on the deck of the *Sea Breeze*, she hauls in the day's catch.



For Janine, fishing for lobsters isn't just a job—it is a way of life. The work follows the rhythms of the seasons and the tides. In winter, Janine has to travel farther out to sea to catch lobsters—sometimes nearly 40 miles offshore. That's 80 miles round trip! In the cool months of early spring, lobster fishing picks up a little but is still fairly slow. There are fewer traps to set and smaller catches.

As the waters warm up through the summer, however, the lobsters become more active. There are more of them, and they are closer to shore. From dawn to dusk, Janine can haul in trap after trap full of lobsters.

On a typical summer day, Janine tends around 100 lobster traps scattered across her fishing territory. Each trap is baited with fish and lowered to the ocean floor. The traps are left to sit for a day or more before she returns to haul them back up.

Fishing for lobster takes strength, and Janine's arms are strong from years of dealing with the heavy traps. A typical trap is around 4 feet long. It is made of metal and weighs around 40 pounds.

When Janine pulls up her traps, she carefully inspects every lobster. Every one has to be measured and must fall within the legal size limits. According to Maine state laws, a lobster must be between $3\frac{1}{4}$ inches and 5 inches from the eye socket to the end of the main body shell in order to be a "keeper." Lobsters that are too small or too large have to be thrown back so they can keep growing and producing young. The rules make sure that there are enough lobsters for coming years.

Janine's daily haul is different each day. A lot depends on the weather and what the lobsters are doing. In early spring, traps catch only a few lobsters. Others might be empty. Janine checks each trap only once or twice a week. But during fall, each trap might catch 10 or more lobsters. After measuring, Janine packs the "keepers" into crates for sale.

Math at Sea

Counting and measuring are a regular part of the lobsterman's routine.

Janine's head is often filled with calculations. How many lobsters has she caught? How many has she thrown back? What price can she charge for her lobsters? One day, she catches 50 lobsters that she can keep. Using that number, she estimates her weekly catch. By multiplying a day's catch by 7, she predicts she might catch around 350 lobsters this week.

During peak lobstering season, Janine often hires a few extra helpers. Together, they might catch 250 or 300 lobsters a day, or somewhere around 2,000 lobsters per week!

Every now and then, with her hands peeling from the rough ropes, Janine thinks about doing a different job. Sometimes she imagines opening a café or bookstore.

But then she laughs at herself. She knows she will never give up life on the sea, no matter how hard the work is. In the end, Janine takes pride in her role. She puts delicious food on the tables of people all over the world. She catches lobsters responsibly, making sure the lobster population remains healthy. To Janine, the ocean is not just her workplace. It feels like home.

Main Idea

Lobstermen use their knowledge of fractions and measurements to manage their harvesting business responsibly.

Solving a Water Problem

Chapter 23

The team has just finished Monday afternoon soccer practice. It is a warm day, and Coach Knox reminds the players that temperatures are expected to climb this week. In fact, by the time they play Friday's match against the Central School team, the temperature is predicted to climb from warm to downright hot!

Marcus, Yami, Nora, and Max hear what the coach is saying. They make sure all their teammates get the message. "Don't forget your water bottle for Wednesday's practice and Friday's game," the friends repeat, each as they say goodbye to other teammates.

On the bus ride to school Tuesday morning, it's already noticeably warmer than it was yesterday. Yami shares something that is on her mind. "I have been thinking about what Coach Knox said after practice yesterday," she says. "It was warm yesterday, and I don't know about you, but I emptied my water bottle before we were even halfway through practice."

"Same here," Marcus chimes in. "I don't think my $\frac{1}{2}$-liter bottle of water will be enough to get me through Friday's game."

"Me neither," adds Max. "Especially with it getting even hotter outside."

Nora has an idea. "Let's meet at my house after school," she says. "I think I have a way to help our team."

After school, in Nora's garage, she shows her friends her idea. It's a big box of plastic water bottles. "These were left over from an event my mom planned where she works," Nora explains. "She was going to donate them to the thrift store downtown. I just asked her, and she said her company would be happy to donate them to our soccer team instead."

"I see what you have in mind," says Yami. "This way everybody on the team can have more than 1 bottle of water. Good thinking. Let's count them to make sure we have enough for everyone on the team."

Max says, "We'll be so cool that we're sure to win!"

The friends count the water bottles and discover there are sixteen $\frac{1}{2}$-liter bottles. “We have 14 players on our team,” says Marcus. “We have a second bottle for everybody.”

“We do,” adds Yami, “if they all bring their own first bottle. Let’s take these to practice tomorrow and hand them out. That way it will remind everyone to bring not 1 but 2 bottles of water with them to the game on Friday.”

“We have a good plan. Let’s decorate these bottles first with stickers,” says Nora. “That way everybody will know which bottle is theirs.”

On Thursday, the friends talk about the water bottles they gave to their teammates.

"Now everybody has at least two $\frac{1}{2}$-liter water bottles," says Yami. "That gives each player a total volume of 1 liter of water. But Coach Knox hit us with another surprise when he said we should all have at least $1\frac{1}{2}$ liters to drink tomorrow at the game."

"I know," says Nora. "And we don't have enough extra water bottles to give every player a third bottle."

"This time I think I might have the solution," says Max. "Let's head to my house."

When the friends arrive at Max's house, he shows them into the garage. "Coach Knox didn't say we need more water bottles," Max says. "He just said we'll need more water."

Nora examines what Max has brought them there to look at—a large cooler with a spout.

"Right," says Nora. "So if we take a big cooler of water, everyone can refill the bottles that they have."

"This holds 5 gallons," Max continues. "That's almost 19 liters! It will be more than enough for everybody to get refill after refill. Now we just have to figure out how to get it there!"

Main Idea

You can use math operations to solve real-world problems such as figuring out how to bring enough water to sports practices or events.

A Curator's Big Day

Chapter
24

Claire is a new curator at the Natural History Museum. She knows today is going to be a big day. She is so excited that she gets to work quite a bit early.

I'd better get started. I've got a lot to do! We have some new teeth to add to our collection.

Claire is in charge of a new exhibit that many people are really excited about: the Fossil Shark Tooth Collection.

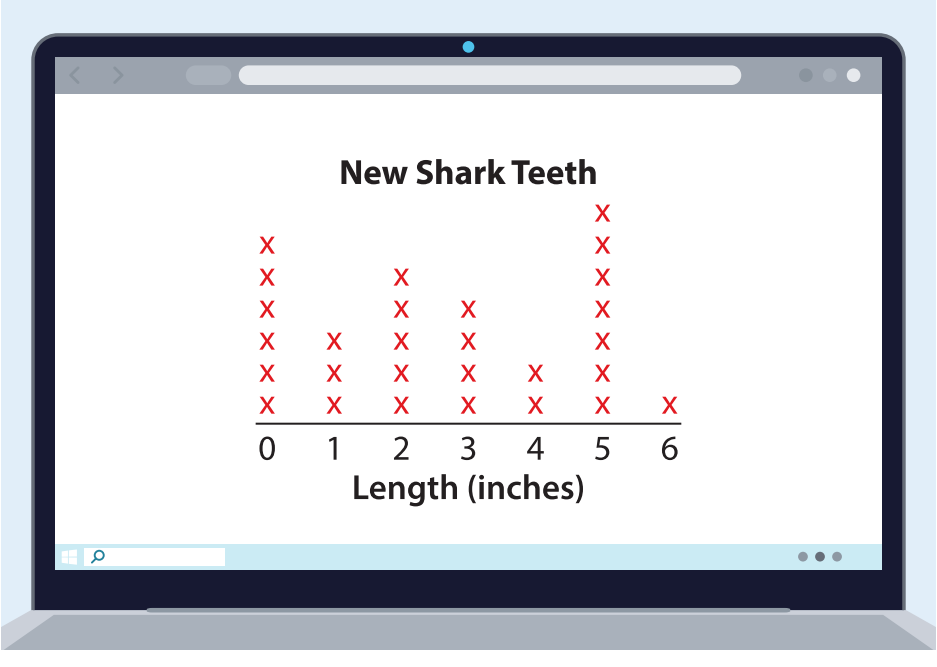
About an hour later . . .

Hey, Claire! You're here early.

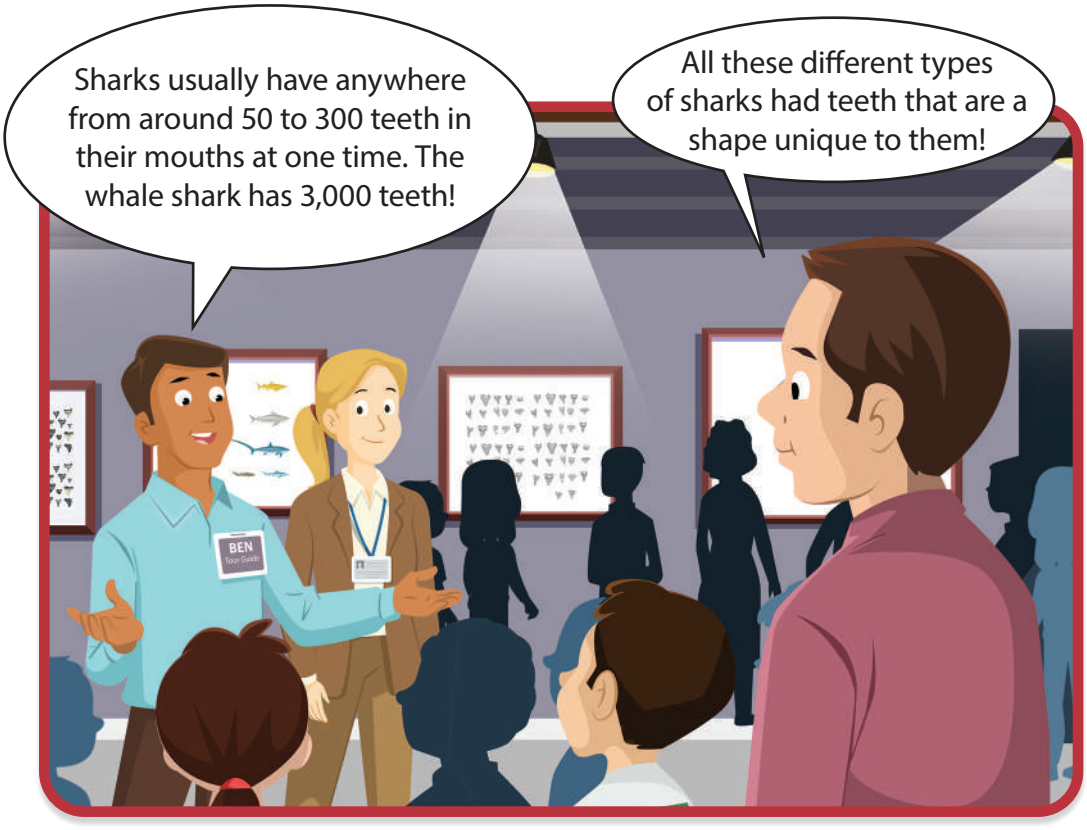
I wanted to get started on the new shark teeth! I've organized the teeth by the type of shark they came from. Now, I'm measuring the size of each tooth. After that, I can add the teeth to our collection.

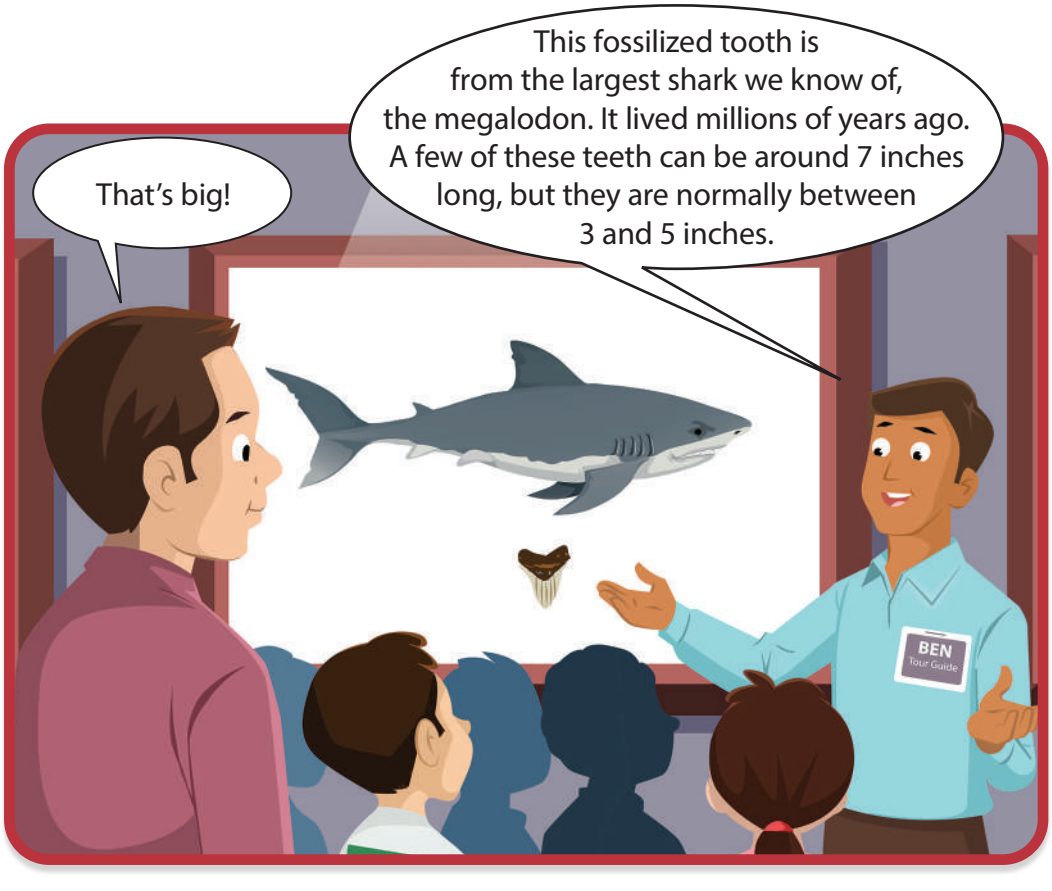
Claire measures each fossil tooth to the nearest quarter inch using a digital caliper. A shark's tooth length is measured diagonally from the tip of the tooth to the corner of the root.

She records the length of each tooth. She rounds each measurement to the nearest inch. Then she makes a line plot to organize the rounded measurements.




SHARK TEETH
Welcome to the exciting world of fossil shark teeth! This is Ben, one of our tour guides. He will guide you through the exhibit. Any questions before we begin?
It is time for the exhibit to open. Claire greets the first tour group. She hopes they are as interested in the shark teeth as she is.
How did you get so many fossil shark teeth?
Sharks lose teeth throughout their lives. And they replace the lost ones with new teeth. A shark might have as many as 30,000 teeth during its life. Over many, many years, these teeth become fossils. There are certain places where we can find these teeth. If you know where to look, it isn't hard to collect shark teeth!
BEN
Tour Guide


Sharks usually have anywhere from around 50 to 300 teeth in their mouths at one time. The whale shark has 3,000 teeth!
All these different types of sharks had teeth that are a shape unique to them!
BEN
Tour Guide


That's big!
This fossilized tooth is from the largest shark we know of, the megalodon. It lived millions of years ago. A few of these teeth can be around 7 inches long, but they are normally between 3 and 5 inches.
BEN
Tour Guide

Main Idea

Museum curators count and measure specimens, and they record and share data.

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Costas Ganasos Photography / Alamy Stock Photo: 11c
Crystite RF / Alamy Stock Photo: 112b
David Osborn / Alamy Stock Photo: 86
Dejan Krsmanovic / Alamy Stock Photo: 121
Dennis Hallinan / Alamy Stock Photo: 99, 100
Dmitrii Melnikov / Alamy Stock Photo: 13
Dorling Kindersley ltd / Alamy Stock Photo: 106a
Edo Schmidt / Alamy Stock Photo: 16
Eric James / Alamy Stock Photo: 32
FALKENSTEINFOTO / Alamy Stock Photo: 105
Feng Yu / Alamy Stock Photo: 1, 108
Florence McGinn / Alamy Stock Photo: 49
Gerald Boehm / Alamy Stock Photo: 90
Guillem Lopez / Alamy Stock Photo: 111
Heritage Image Partnership Ltd / Alamy Stock Photo: 27b
History & Art Collection / Alamy Stock Photo: 102
Image Source Limited / Alamy Stock Photo: 11a, 63
Image Source Limited / Alamy Stock Vector: 14
imageBROKER.com / Alamy Stock Photo: 74, 119
Ivan Pesic: Cover A–D, i, iii
Ivan Sizov / Alamy Stock Photo: 88a
Jeffrey Isaac Greenberg 8+ / Alamy Stock Photo: 28
Jeffrey Rotman / Alamy Stock Photo: 130
Jim Kidd / Alamy Stock Photo: 128
Joel Papalini / Alamy Stock Photo: 79
Juergen Hasenkopf / Alamy Stock Photo: 65
Kemphoto artistic works / Alamy Stock Photo: 35
Kim Karpeles / Alamy Stock Photo: 37
Kris Wiktor / Alamy Stock Photo: 48
Kristoffer Tripplaar / Alamy Stock Photo: 81
Lisa Holder / Alamy Stock Photo: 51
Maksym Kapusta / Alamy Stock Photo: 109
malbraman / Alamy Stock Photo: 113a
margherita del piano / Alamy Stock Photo: 107
Mariano Garcia / Alamy Stock Photo: 101
Mariusz Szczawinski / Alamy Stock Photo: 75, 133
Mark Collinson / Alamy Stock Photo: 52
Mark Kanning / Alamy Stock Photo: 29
Massimo Portolani / Alamy Stock Photo: 117
Mauro Carli / Alamy Stock Photo: 77
Michael Burrell / Alamy Stock Photo: 78a
Michele Falzone / Alamy Stock Photo: 110
Mollie Delaria / Alamy Stock Photo: 103
NaturaLight - No Release Needed / Alamy Stock Photo: 34
Oleksiy Maksymenko Photography / Alamy Stock Photo: 89b
Orcea David / Alamy Stock Photo: 89c
Paul Brady / Alamy Stock Photo: 44
Paul Hamilton / Alamy Stock Photo: 31
Peter Hermes Furian / Alamy Stock Photo: 19
Peter Horree / Alamy Stock Photo: 98
Photology1971 / Alamy Stock Photo: 9
Rabia Elif Aksoy / Alamy Stock Photo: 82
Rainer Lesniewski / Alamy Stock Vector: 91
Realimage / Alamy Stock Photo: 87
Scott Camazine / Alamy Stock Photo: 21
Serhii Kucher / Alamy Stock Photo: 114a
S-Jo / Alamy Stock Photo: 17a
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Sybren Jansma / Alamy Stock Photo: 24b
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Tetra Images / Alamy Stock Photo: 131
The History Collection / Alamy Stock Photo: 46
Thomas Richards / Alamy Stock Photo: 55
tom carter / Alamy Stock Photo: 26
Toniflap / Alamy Stock Photo: 113b
Tony Vingerhoets / Alamy Stock Photo: 15
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