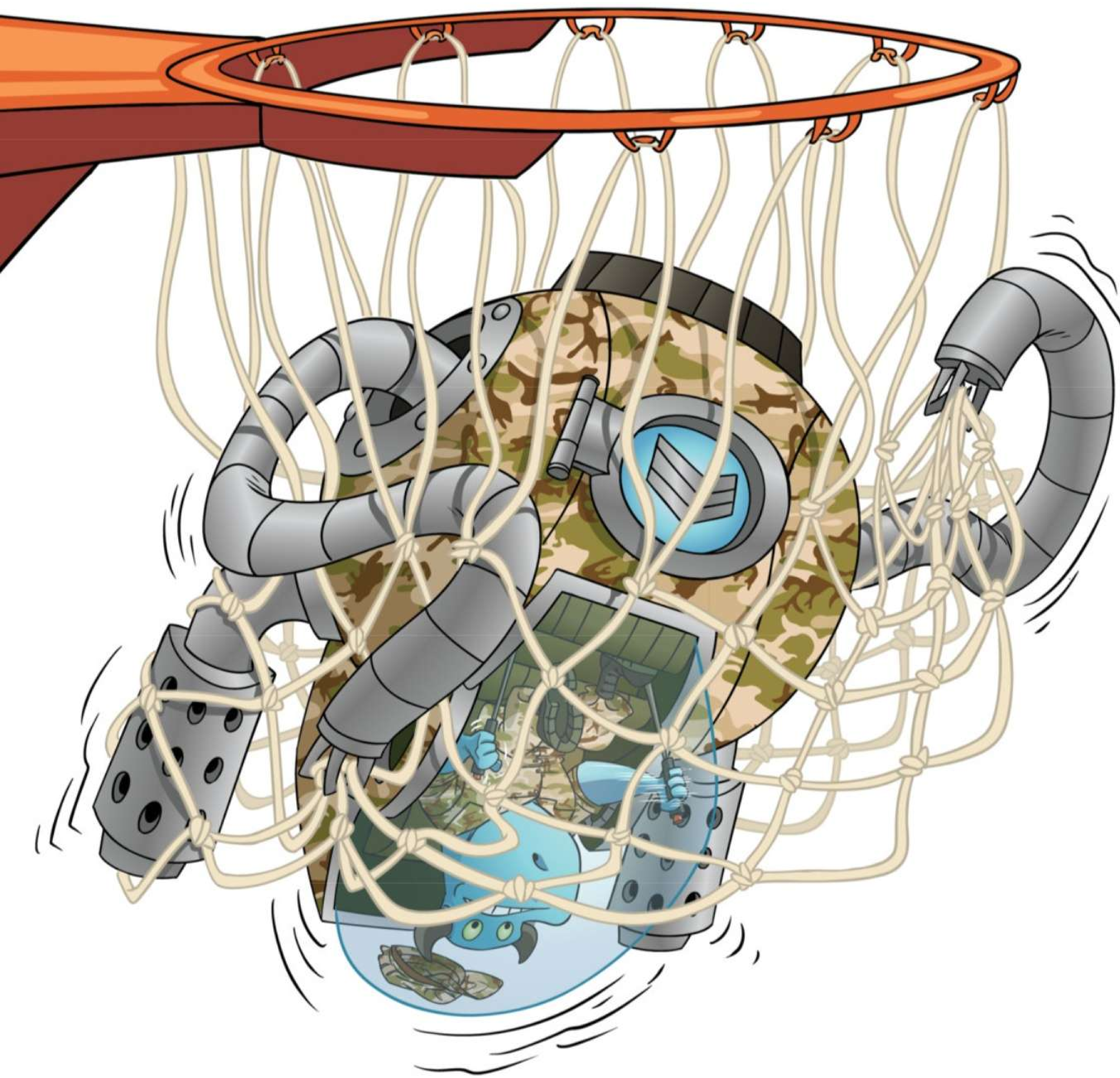
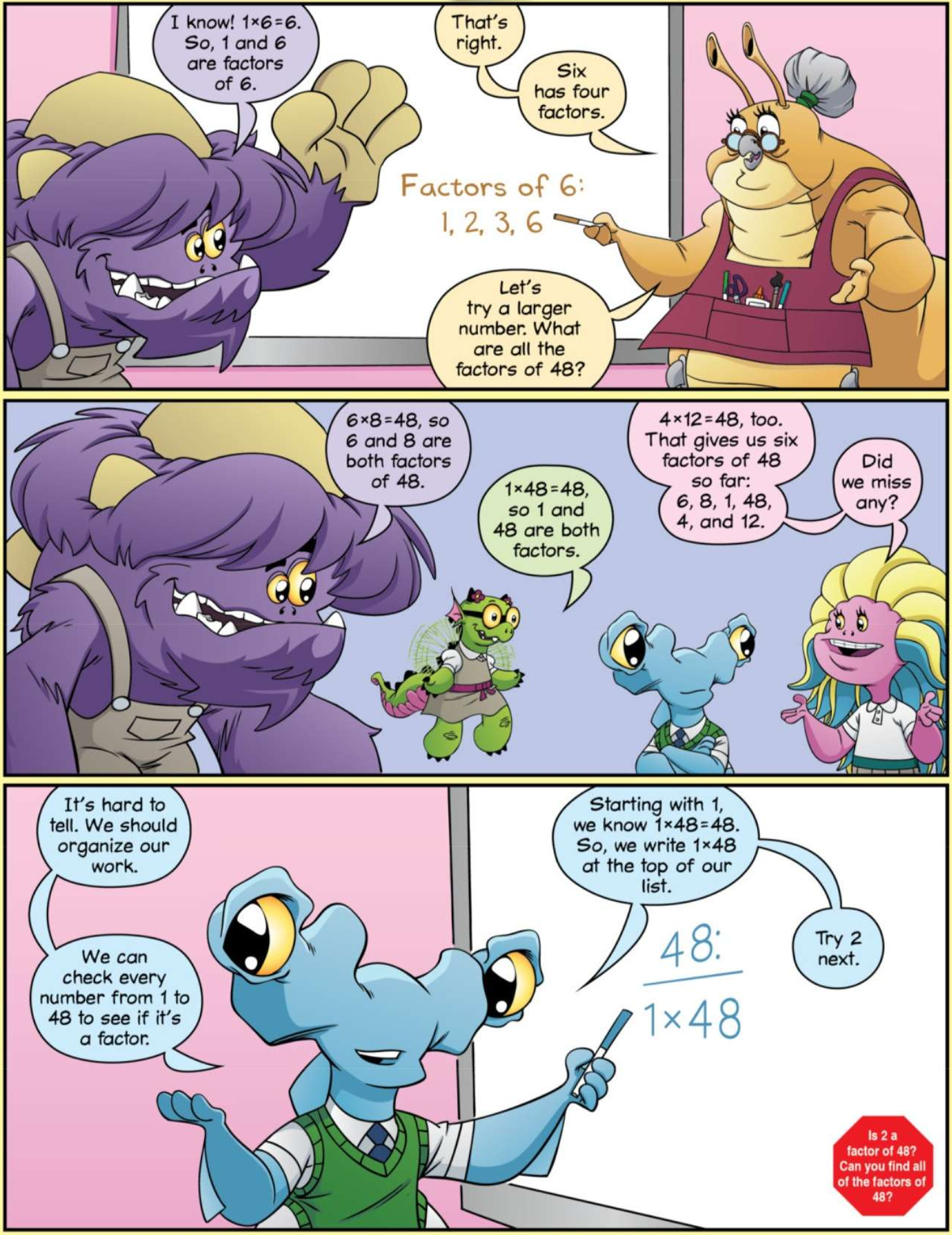
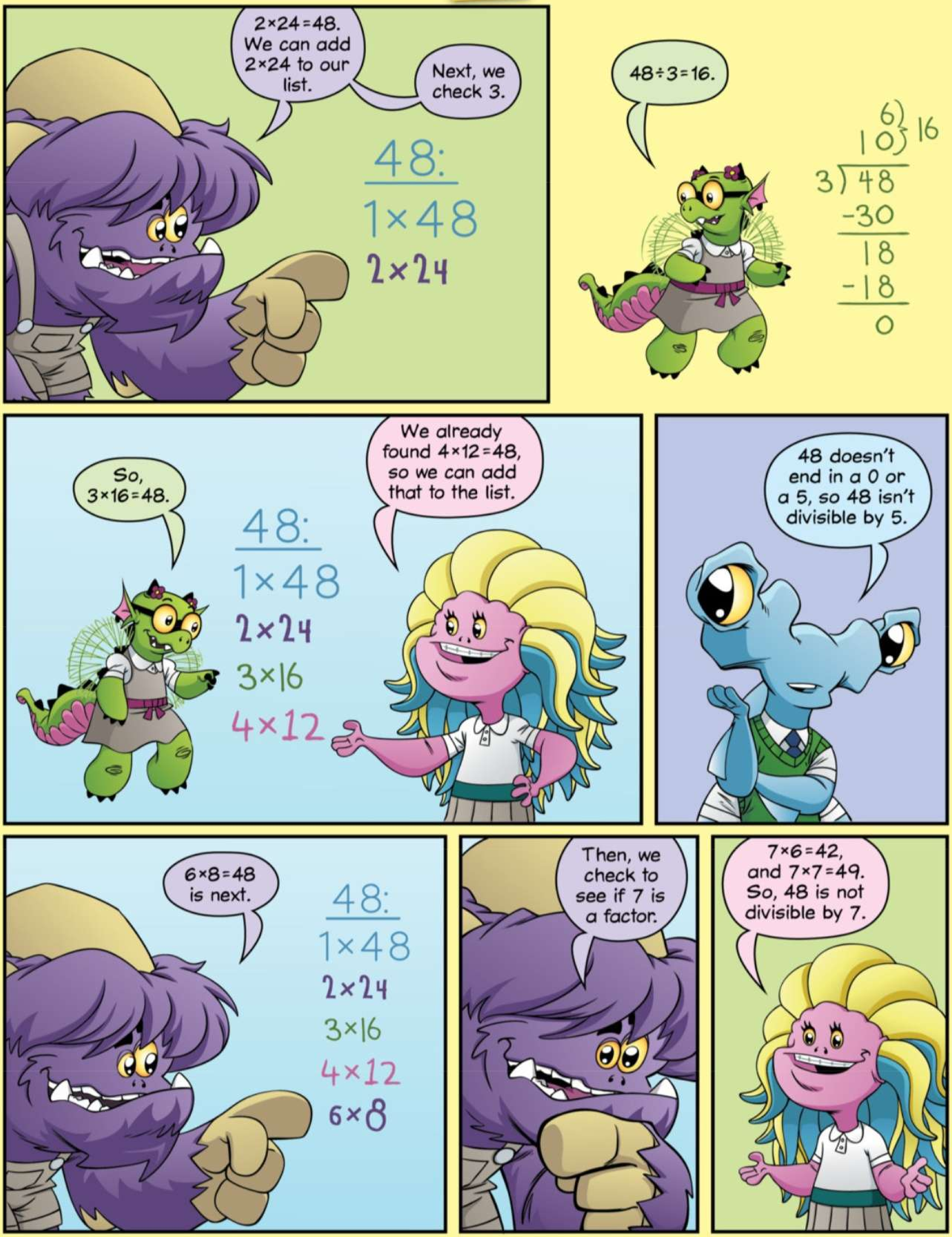
Chapter 7:
Factors



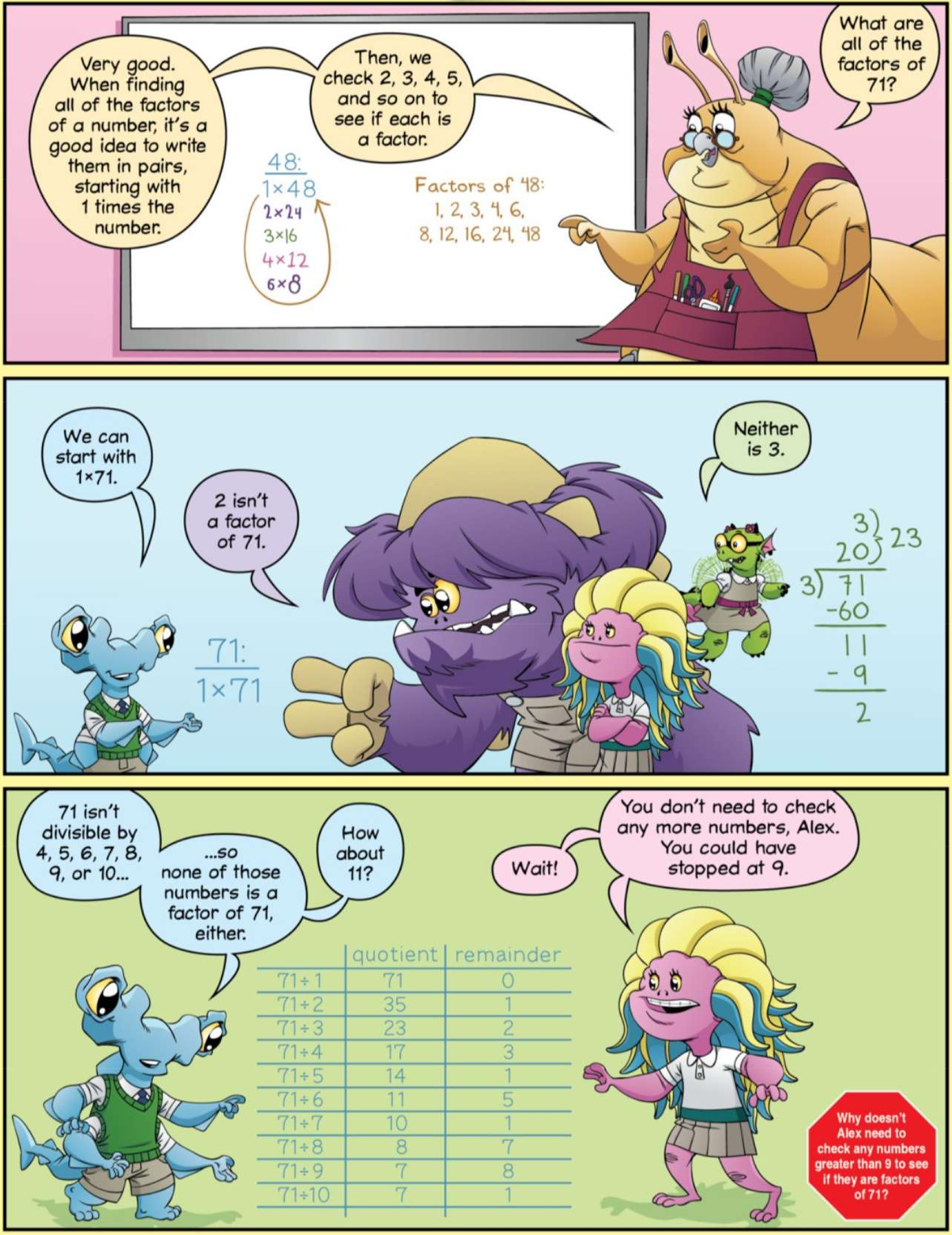
Ms. Q.
Factors
What are factors?
Factors are the numbers that you multiply to get other numbers.
Huh?
For example, when you multiply 2×3, you get 6.
So, we say that 2 and 3 are *factors* of 6.
Factors are the numbers that a number is divisible by.
Since 6 is *divisible* by 3, we say that 3 is a *factor* of 6.
Very good. Does 6 have any other factors?
Hmmm... What other numbers can we multiply to get 6?



I know! 1×6=6. So, 1 and 6 are factors of 6.
That's right.
Six has four factors.
Factors of 6:
1, 2, 3, 6
Let's try a larger number. What are all the factors of 48?
6×8=48, so 6 and 8 are both factors of 48.
1×48=48, so 1 and 48 are both factors.
4×12=48, too. That gives us six factors of 48 so far: 6, 8, 1, 48, 4, and 12.
Did we miss any?
It's hard to tell. We should organize our work.
We can check every number from 1 to 48 to see if it's a factor.
Starting with 1, we know 1×48=48. So, we write 1×48 at the top of our list.
Try 2 next.
48:
1×48
Is 2 a factor of 48? Can you find all of the factors of 48?


2×24=48. We can add 2×24 to our list.
Next, we check 3.
48:
1×48
2×24
48÷3=16.
6) 10) 16
3)48
-30
18
-18
0
So, 3×16=48.
We already found 4×12=48, so we can add that to the list.
48:
1×48
2×24
3×16
4×12
48 doesn't end in a 0 or a 5, so 48 isn't divisible by 5.
6×8=48 is next.
48:
1×48
2×24
3×16
4×12
6×8
Then, we check to see if 7 is a factor.
7×6=42, and 7×7=49. So, 48 is not divisible by 7.

Let's try 8.
48:
1×48
2×24
3×16
4×12
6×8
Grogg! You just wrote that 8 is a factor: 6×8=48.
Oh, right. What about 9?
9×5 is 45, and 9×6 is 54, so 9 isn't a factor of 48.
Neither is 10. How about 11?
Wait a second. We don't need to keep checking the bigger numbers.
Why not, Winnie?
Well, we know that 7×7 is 49.
So, any number that is ***larger*** than 7 has to be multiplied by a number that's ***smaller*** than 7 to get 48.
And we've already found all of the factors of 48 that are smaller than 7.
48:
1×48
2×24
3×16
4×12
6×8
The factors that are larger than 7 are paired with the factors that are smaller than 7.
So, we've already found all the factors of 48 that are larger than 7.
48 has ten factors.

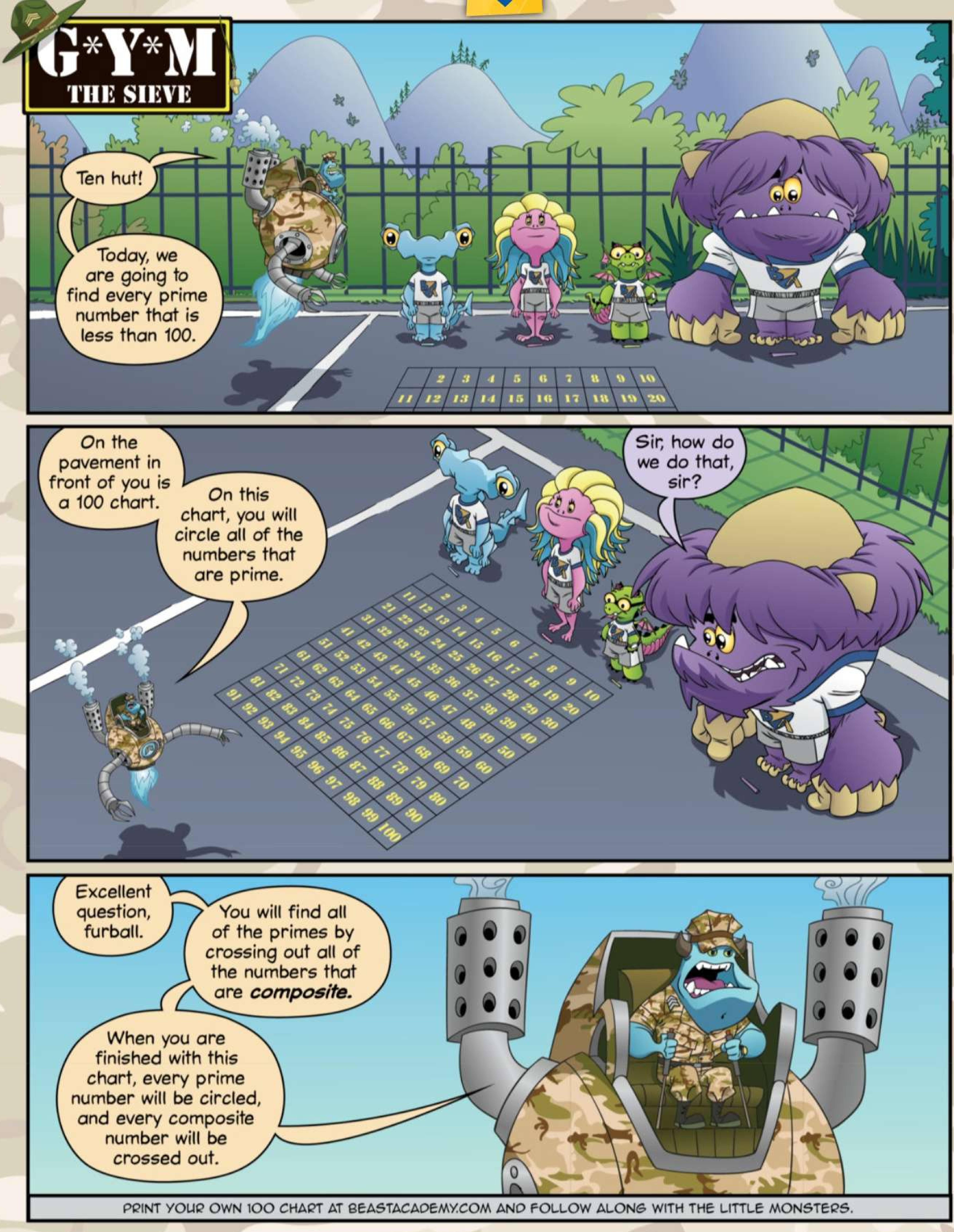


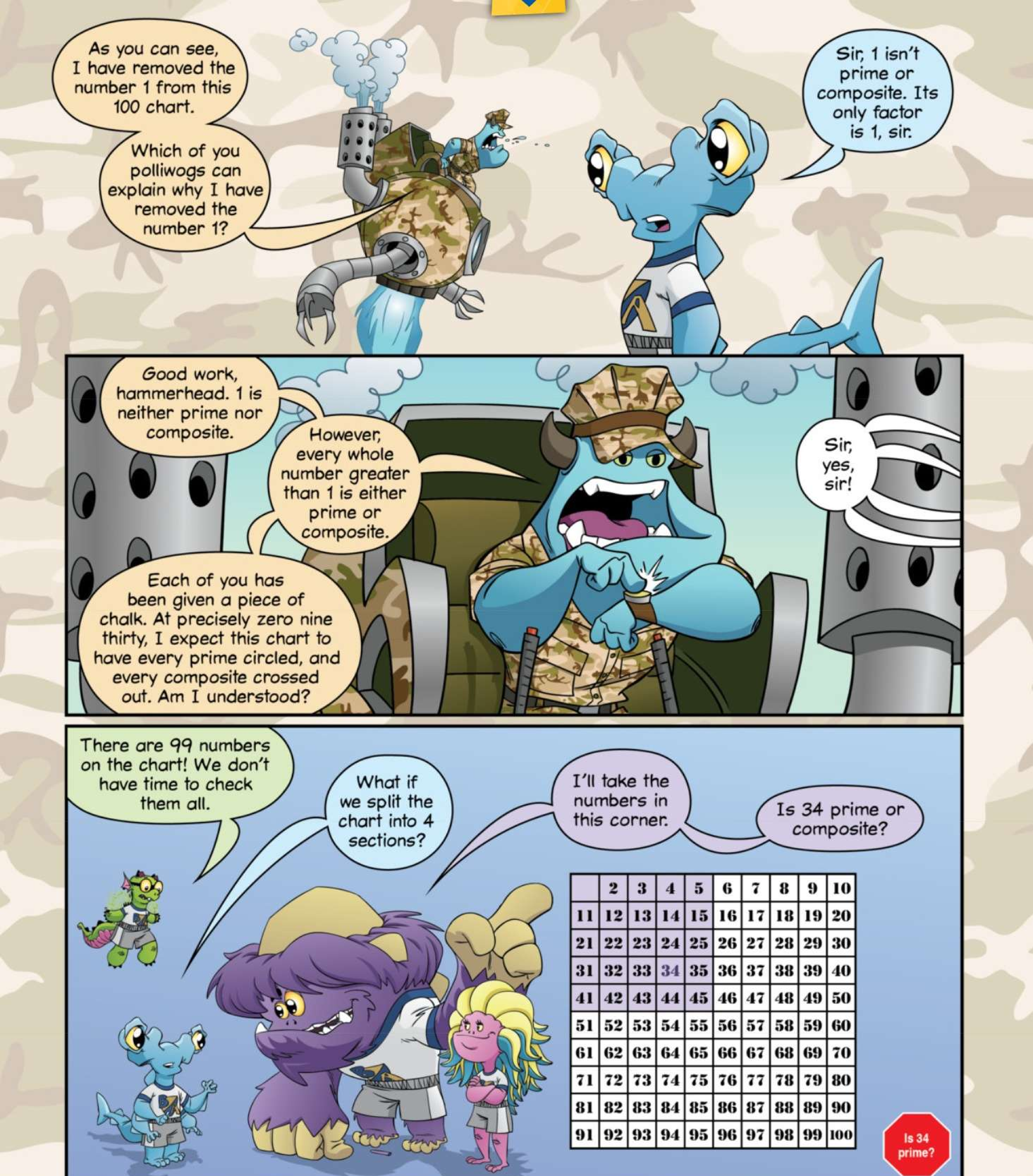
Very good. When finding all of the factors of a number, it's a good idea to write them in pairs, starting with 1 times the number.
Then, we check 2, 3, 4, 5, and so on to see if each is a factor.
What are all of the factors of 71?
48:
1×48
2×24
3×16
4×12
6×8
Factors of 48:
1, 2, 3, 4, 6, 8, 12, 16, 24, 48
We can start with 1×71.
2 isn't a factor of 71.
Neither is 3.
71:
1×71
3) 71
-60
11
- 9
2
20
3
23
71 isn't divisible by 4, 5, 6, 7, 8, 9, or 10...
...so none of those numbers is a factor of 71, either.
How about 11?
Wait!
You don't need to check any more numbers, Alex. You could have stopped at 9.
quotient | remainder
71÷1 | 71 | 0
71÷2 | 35 | 1
71÷3 | 23 | 2
71÷4 | 17 | 3
71÷5 | 14 | 1
71÷6 | 11 | 5
71÷7 | 10 | 1
71÷8 | 8 | 7
71÷9 | 7 | 8
71÷10 | 7 | 1
Why doesn't Alex need to check any numbers greater than 9 to see if they are factors of 71?

Since 9×9=81, any number that is ***larger*** than 9 has to be multiplied by a number that's ***smaller*** than 9 to get a product that is less than 81.
So, to get a product of 71 using a number that is larger than 9, we have to multiply by a number that's smaller than 9.
Since 1 is the only factor of 71 that is smaller than 9...
...we know that 71 is the only factor of 71 that is larger than 9.
That means 1 and 71 are the only factors of 71.
That's right. The number 71 has only two factors, 1 and 71.
Does anyone know what we call a number whose only factors are 1 and itself?
71:
1×71
A number with exactly 2 factors, 1 and itself, is called a ***prime number***.
Very good, Lizzie.
Which of these 1-digit numbers are prime?
Circle the primes:
0, 1, 2, 3, 4, 5, 6, 7, 8, 9
Try it.
NUMBERS THAT ARE PRIME ARE OFTEN SIMPLY CALLED "PRIMES."

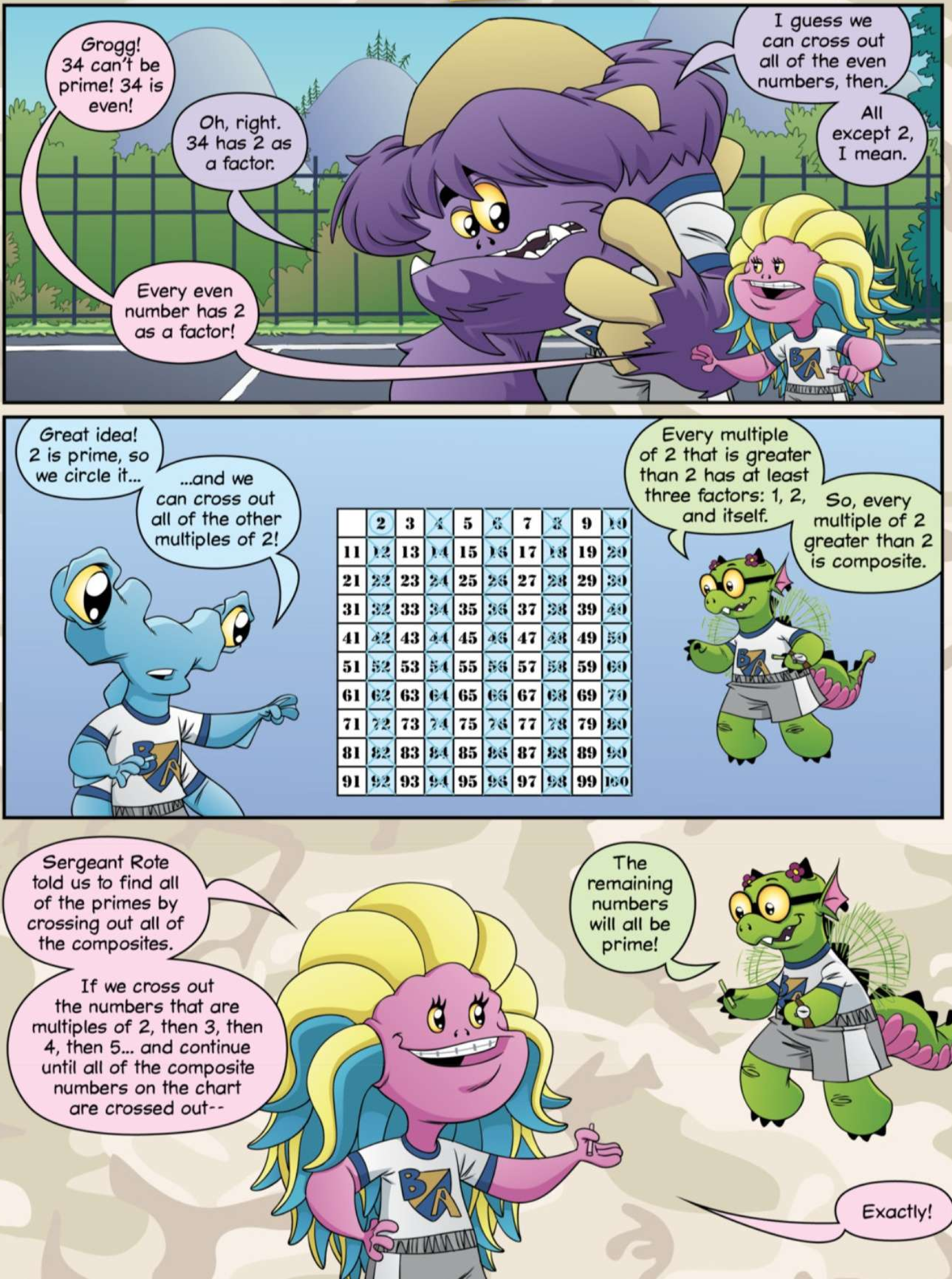
POSITIVE MEANS GREATER THAN 0. WE WILL LEARN ABOUT NUMBERS THAT ARE LESS THAN 0 IN CHAPTER 9.


So, 5 is prime, 6 is composite, 7 is prime...
...8 is composite, and 9 is composite.
5:
1×5
prime
6:
1×6
2×3
composite
7:
1×7
prime
8:
1×8
2×4
composite
9:
1×9
3×3
composite
The 1-digit primes are 2, 3, 5, and 7.
Circle the primes:
0, 1, 2, 3, 4, 5, 6, 7, 8, 9
Is 41 prime, too, Ms. Q.?
It is, Grogg. Why do you ask?
Last week, my dad turned 41.
I asked him if he felt old. He said...
Not me. I'm in my *prime*.
41

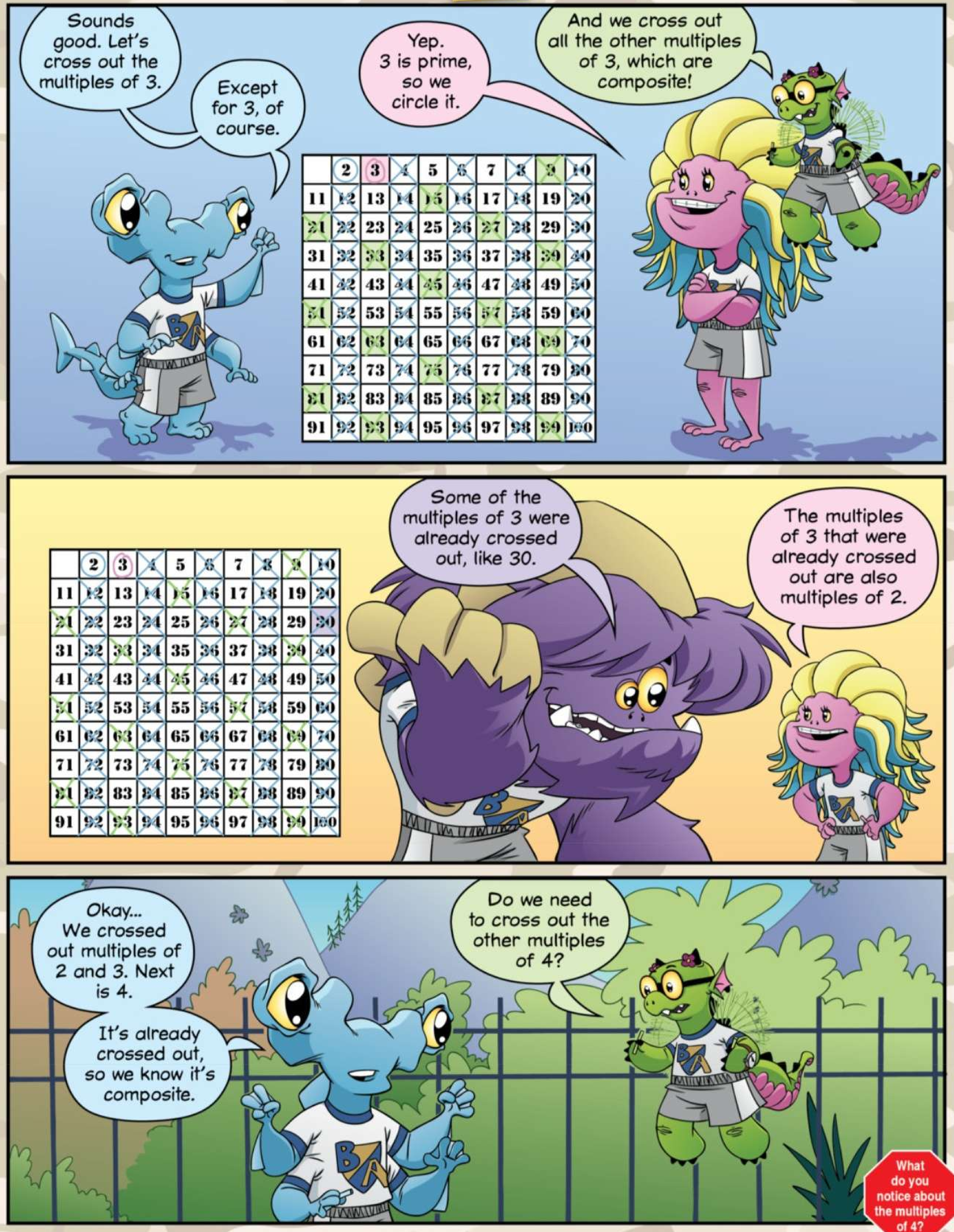

G*Y*M
THE SIEVE
Ten hut!
Today, we are going to find every prime number that is less than 100.
On the pavement in front of you is a 100 chart.
On this chart, you will circle all of the numbers that are prime.
Sir, how do we do that, sir?
Excellent question, furball.
You will find all of the primes by crossing out all of the numbers that are ***composite.***
When you are finished with this chart, every prime number will be circled, and every composite number will be crossed out.
PRINT YOUR OWN 100 CHART AT BEASTACADEMY.COM AND FOLLOW ALONG WITH THE LITTLE MONSTERS.



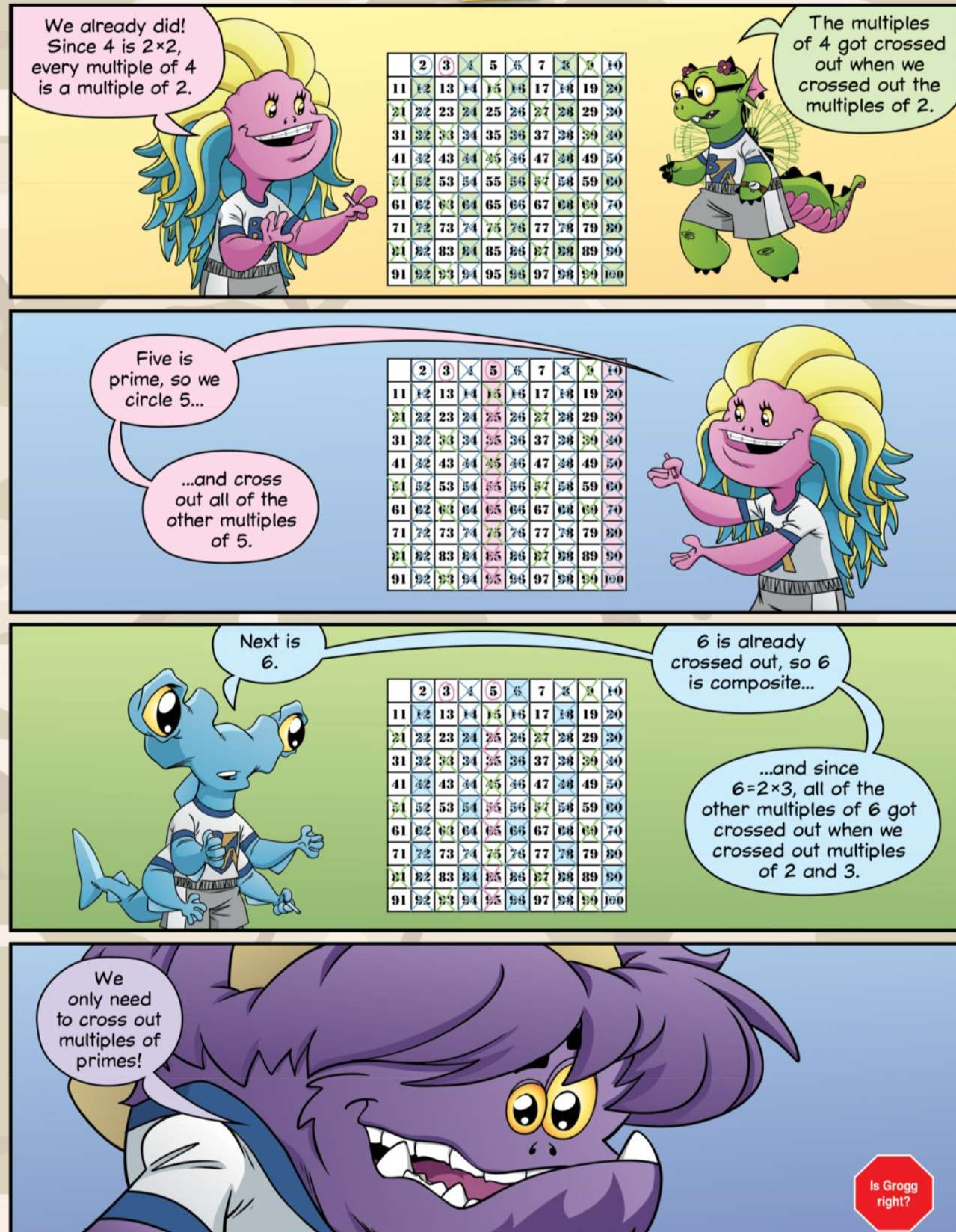
	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100

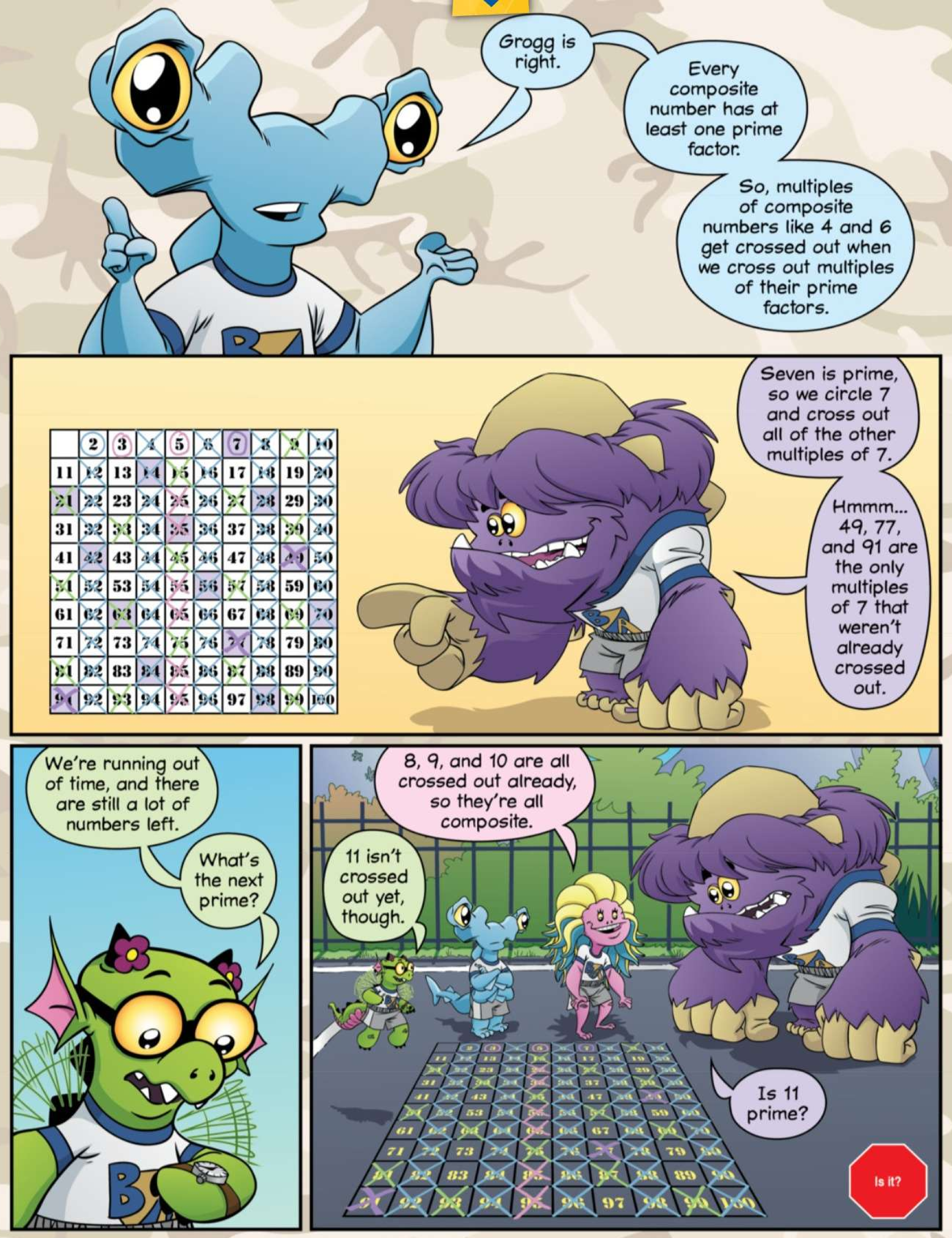


Grogg! 34 can't be prime! 34 is even!
Oh, right. 34 has 2 as a factor.
Every even number has 2 as a factor!
I guess we can cross out all of the even numbers, then.
All except 2, I mean.
Great idea! 2 is prime, so we circle it...
...and we can cross out all of the other multiples of 2!
2 3 4 5 6 7 8 9 10
11 12 13 14 15 16 17 18 19 20
21 22 23 24 25 26 27 28 29 30
31 32 33 34 35 36 37 38 39 40
41 42 43 44 45 46 47 48 49 50
51 52 53 54 55 56 57 58 59 60
61 62 63 64 65 66 67 68 69 70
71 72 73 74 75 76 77 78 79 80
81 82 83 84 85 86 87 88 89 90
91 92 93 94 95 96 97 98 99 100
Every multiple of 2 that is greater than 2 has at least three factors: 1, 2, and itself.
So, every multiple of 2 greater than 2 is composite.
Sergeant Rote told us to find all of the primes by crossing out all of the composites.
If we cross out the numbers that are multiples of 2, then 3, then 4, then 5... and continue until all of the composite numbers on the chart are crossed out--
The remaining numbers will all be prime!
Exactly!

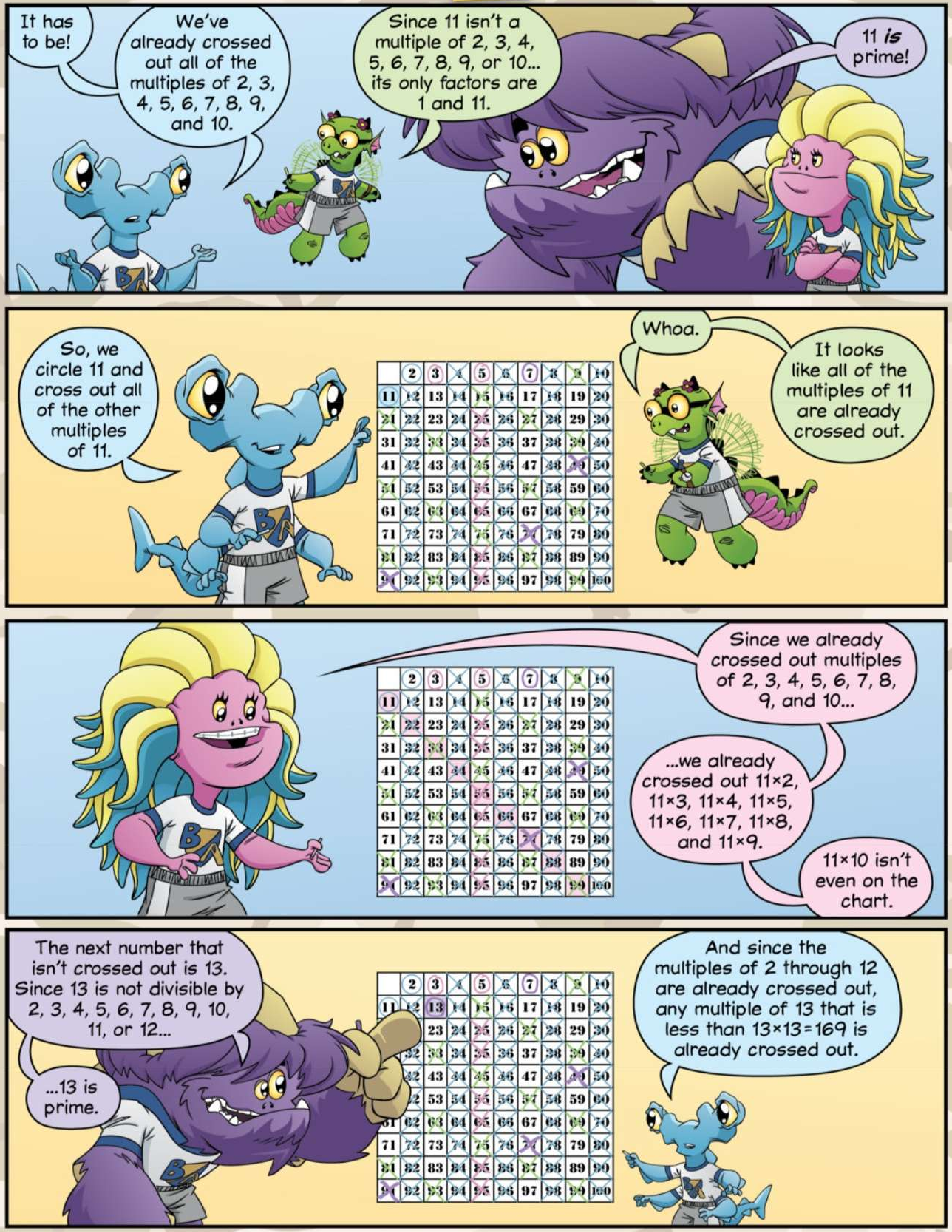


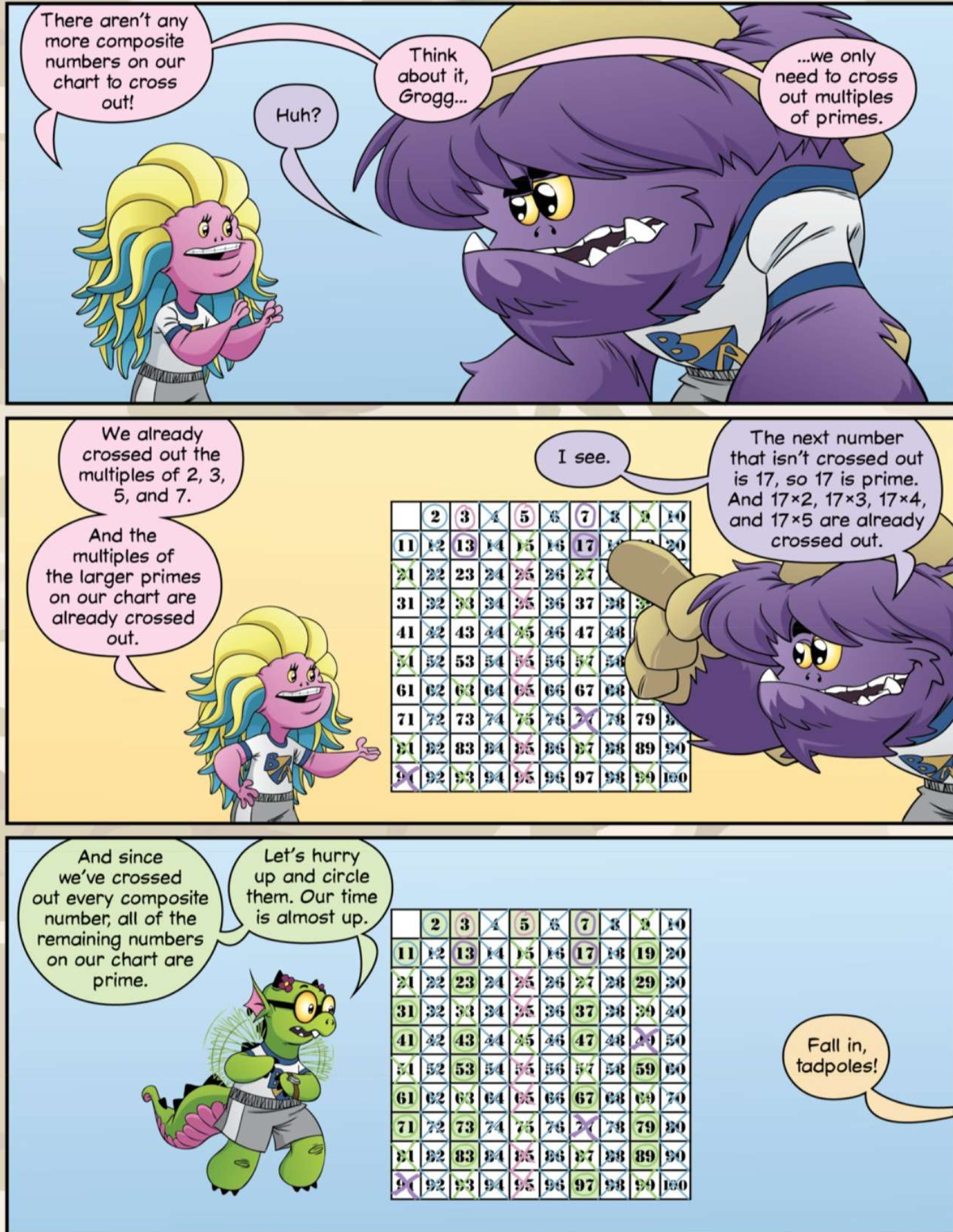
Sounds good. Let's cross out the multiples of 3.
Except for 3, of course.
Yep. 3 is prime, so we circle it.
And we cross out all the other multiples of 3, which are composite!
Some of the multiples of 3 were already crossed out, like 30.
The multiples of 3 that were already crossed out are also multiples of 2.
Okay... We crossed out multiples of 2 and 3. Next is 4.
It's already crossed out, so we know it's composite.
Do we need to cross out the other multiples of 4?
What do you notice about the multiples of 4?


We already did! Since 4 is 2×2, every multiple of 4 is a multiple of 2.
The multiples of 4 got crossed out when we crossed out the multiples of 2.
Five is prime, so we circle 5...
...and cross out all of the other multiples of 5.
Next is 6.
6 is already crossed out, so 6 is composite...
...and since 6=2×3, all of the other multiples of 6 got crossed out when we crossed out multiples of 2 and 3.
We only need to cross out multiples of primes!
Is Grogg right?



Grogg is right.
Every composite number has at least one prime factor.
So, multiples of composite numbers like 4 and 6 get crossed out when we cross out multiples of their prime factors.
Seven is prime, so we circle 7 and cross out all of the other multiples of 7.
Hmmm... 49, 77, and 91 are the only multiples of 7 that weren't already crossed out.
We're running out of time, and there are still a lot of numbers left.
What's the next prime?
8, 9, and 10 are all crossed out already, so they're all composite.
11 isn't crossed out yet, though.
Is 11 prime?
Is it?


It has to be!
We've already crossed out all of the multiples of 2, 3, 4, 5, 6, 7, 8, 9, and 10.
Since 11 isn't a multiple of 2, 3, 4, 5, 6, 7, 8, 9, or 10... its only factors are 1 and 11.
11 *is* prime!
So, we circle 11 and cross out all of the other multiples of 11.
Whoa.
It looks like all of the multiples of 11 are already crossed out.
Since we already crossed out multiples of 2, 3, 4, 5, 6, 7, 8, 9, and 10...
...we already crossed out 11×2, 11×3, 11×4, 11×5, 11×6, 11×7, 11×8, and 11×9.
11×10 isn't even on the chart.
The next number that isn't crossed out is 13. Since 13 is not divisible by 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, or 12...
...13 is prime.
And since the multiples of 2 through 12 are already crossed out, any multiple of 13 that is less than 13×13=169 is already crossed out.


There aren't any more composite numbers on our chart to cross out!
Huh?
Think about it, Grogg...
...we only need to cross out multiples of primes.
We already crossed out the multiples of 2, 3, 5, and 7.
And the multiples of the larger primes on our chart are already crossed out.
I see.
The next number that isn't crossed out is 17, so 17 is prime. And 17×2, 17×3, 17×4, and 17×5 are already crossed out.
And since we've crossed out every composite number, all of the remaining numbers on our chart are prime.
Let's hurry up and circle them. Our time is almost up.
Fall in, tadpoles!


Pinkie! How many numbers on this chart are prime?
Sir, 25, sir!
And how did you find all 25 primes so fast, tinkerbell?
Sir, by crossing out all of the composite numbers, sir.
The process you just used was developed by an ancient math beast named Eratosthenes.*
The Bots can be programmed to use this process to generate enormous lists of primes quickly and efficiently.
I expect you to recognize all of your 1- and 2-digit primes by week's end, is that understood?
Sir, yes, sir!
*THE PROCESS IS CALLED THE SIEVE OF ERATOSTHENES (PRONOUNCED SIV OF AIR-UH-*TOSS*-THE-KNEES).
Ninety-one is not a prime.
Ninety-one is not a prime.
That one tricks me every time.
That one tricks me every time.

RECESS

Fizz Buzz

Game Play:

Fizz Buzz is a counting game for two or more players, but is best when played with 5 or more. Players arrange themselves in a circle. Player 1 begins the game by saying “1.” The player to the left says “2.” Play continues clockwise around the circle with each player stating the next number. However, any multiple of 3 is replaced with the word “fizz,” and any multiple of 5 is replaced with the word “buzz.” A multiple of both 3 and 5 is replaced with the word “fizzbuzz.”

For example, a standard round of Fizz Buzz begins as shown:

1, 2, fizz, 4, buzz, fizz, 7, 8, fizz, buzz, 11, fizz, 13, 14, fizzbuzz, 16, 17, fizz, 19, buzz, fizz, 22, 23, fizz, buzz, ...

Any player who hesitates or makes a mistake is eliminated, and the player to his or her left begins the next round at 1. Play continues until only one player remains. That player is declared the winner.

Variations:

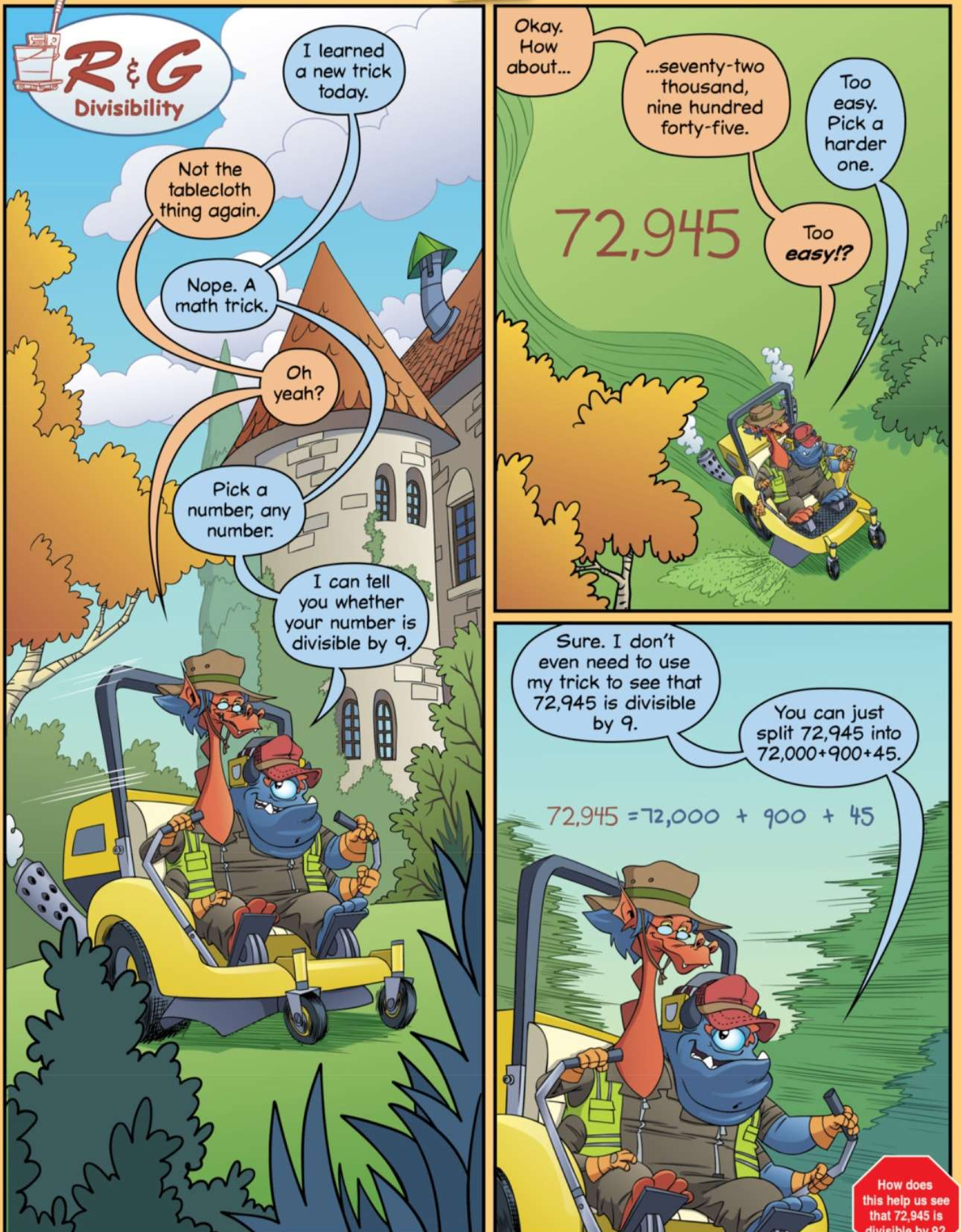
- Different factors can replace 3 and 5. Similarly, different words or gestures can replace the words “fizz” and “buzz.” For example, multiples of 3 can be replaced with a clap, and multiples of 7 can be replaced with a hop, with multiples of both 3 and 7 replaced with a clap and a hop.
- Play switches direction on the word fizz or buzz, but not the word fizzbuzz.
- Additional factors with associated words and gestures can be added to make the game even more difficult.
- Instead of restarting at 1 after a mistake, play can resume at the number on which the mistake was made.

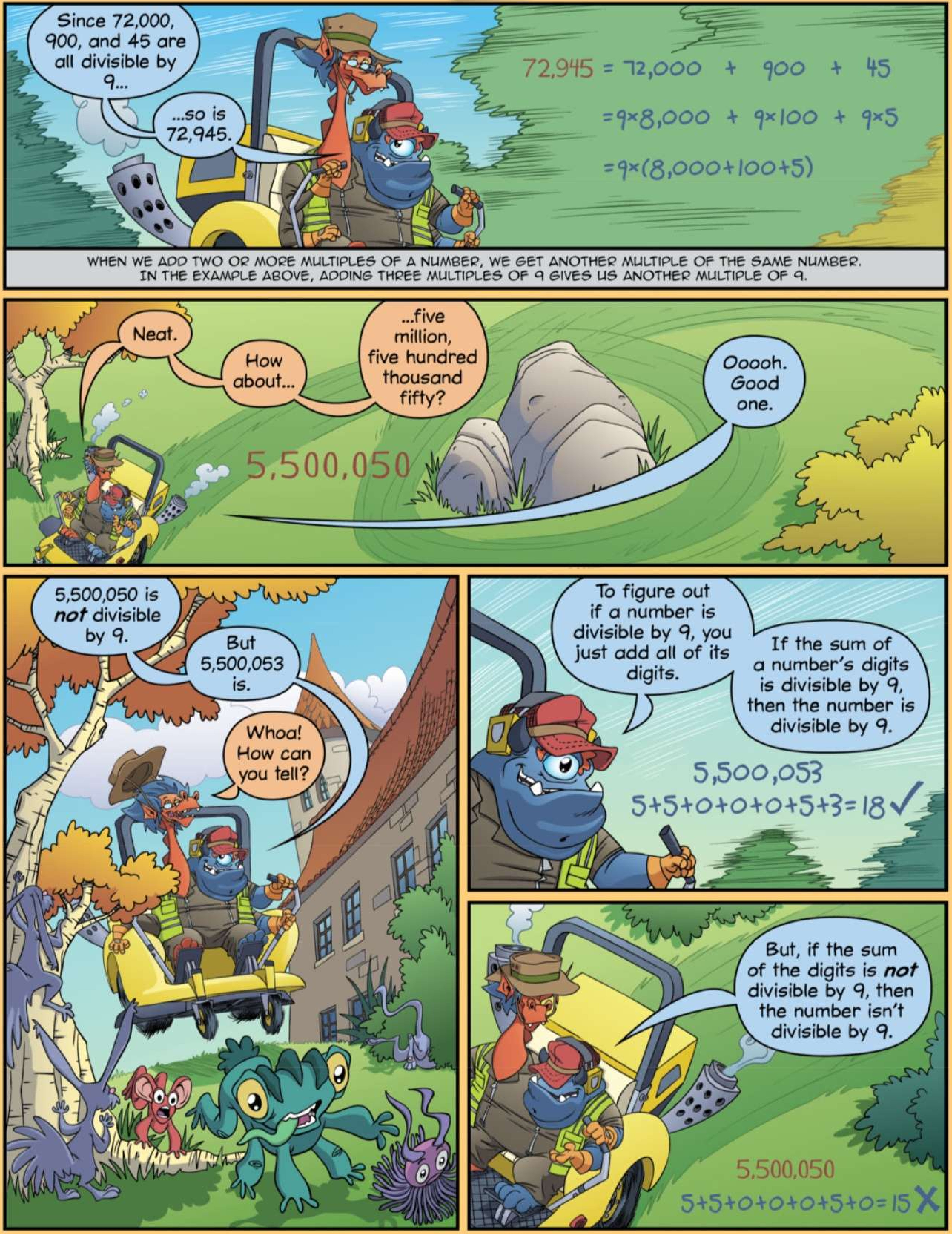
Even better when played in a large group!

Cheat Sheet:

Give this list to an adult so they can referee a game of Fizz Buzz between you and your friends.

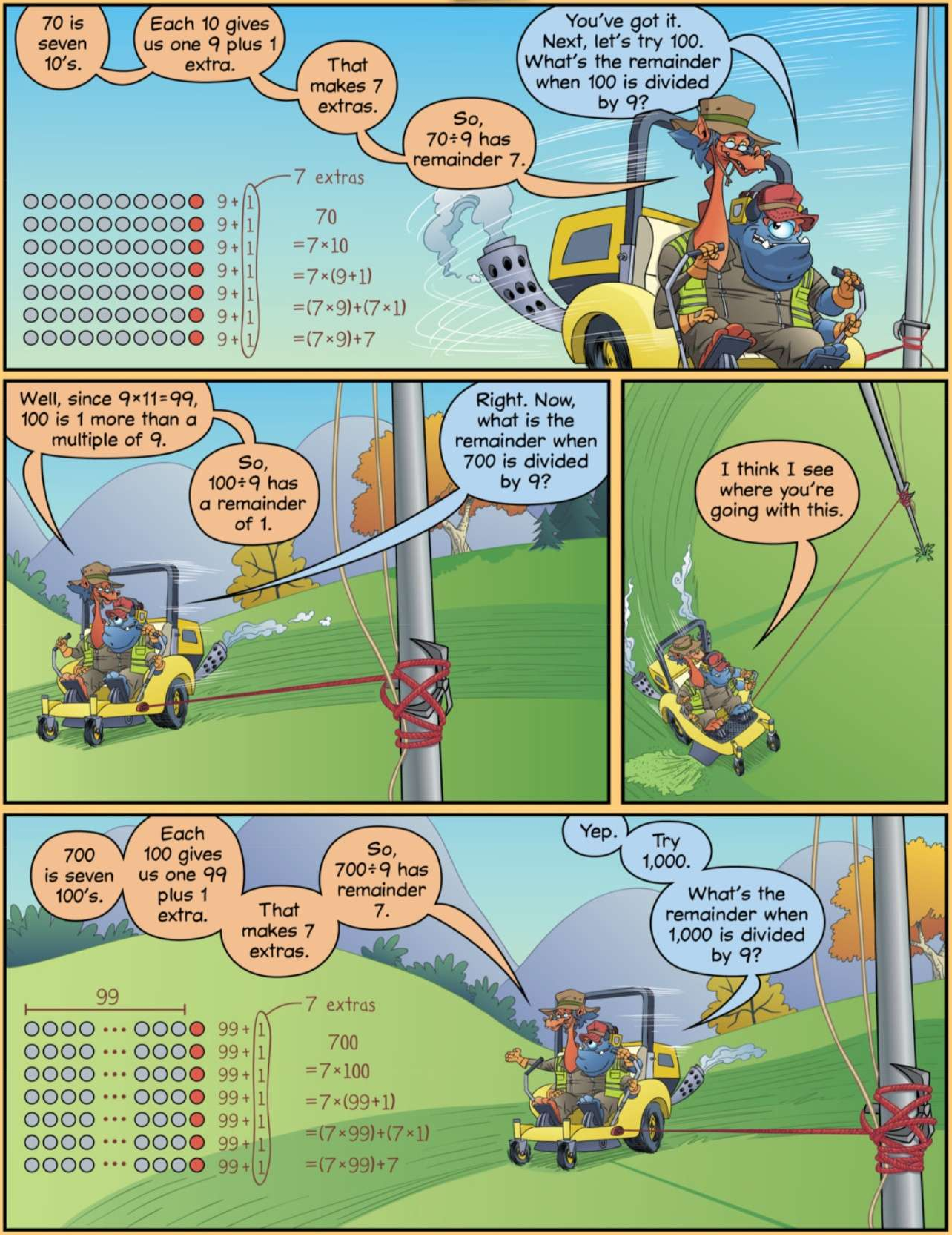
1	34	67
2	buzz	68
fizz	fizz	fizz
4	37	buzz
buzz	38	71
fizz	fizz	fizz
7	buzz	73
8	41	74
fizz	fizz	fizzbuzz
buzz	43	76
11	44	77
fizz	fizzbuzz	fizz
13	46	79
14	47	buzz
fizzbuzz	fizz	fizz
16	49	82
17	buzz	83
fizz	fizz	fizz
19	52	buzz
buzz	53	86
fizz	fizz	fizz
22	buzz	88
23	56	89
fizz	fizz	fizzbuzz
buzz	58	91
26	59	92
fizz	fizzbuzz	fizz
28	61	94
29	62	buzz
fizzbuzz	fizz	fizz
31	64	97
32	buzz	98
fizz	fizz	fizz

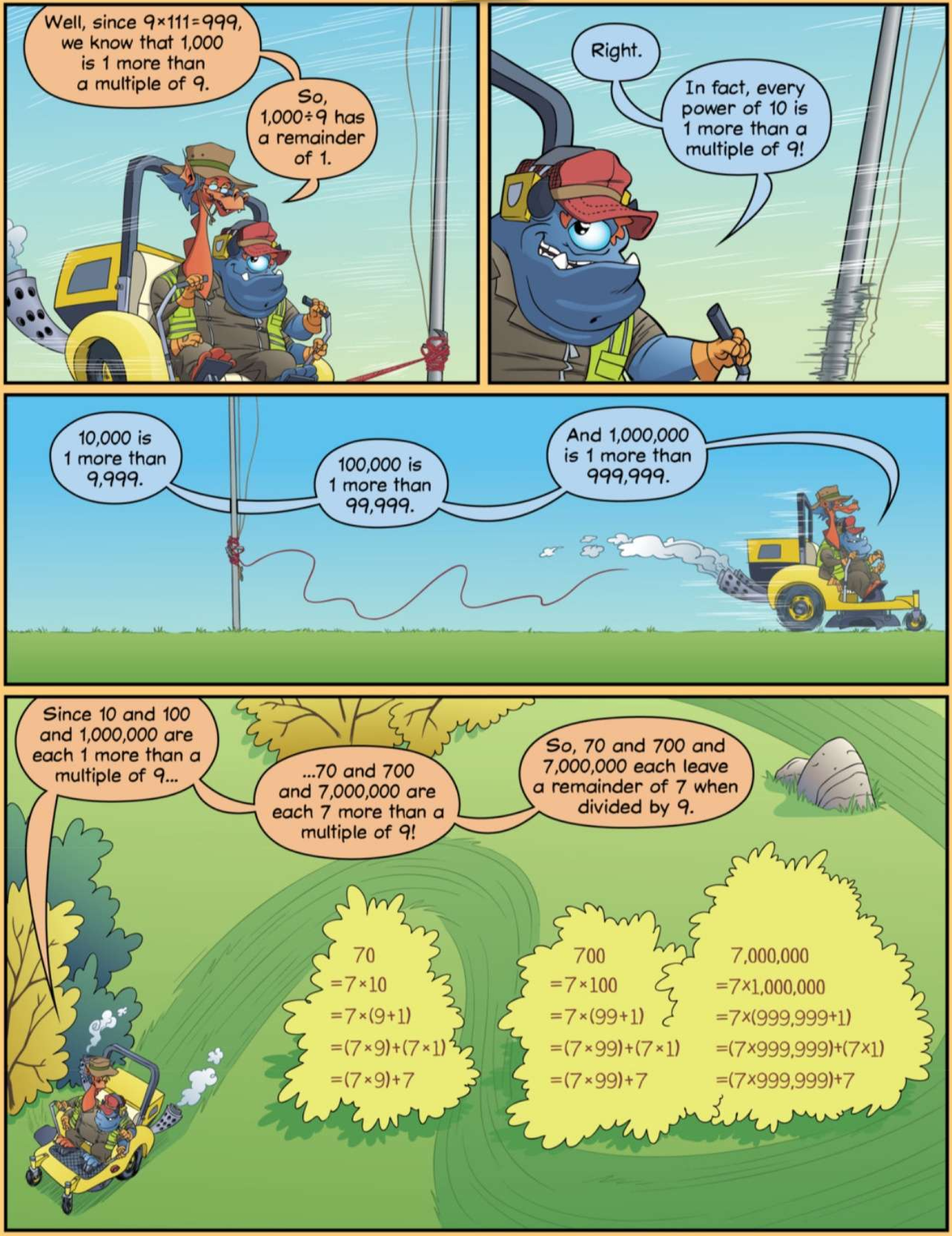

R&G
Divisibility
I learned a new trick today.
Not the tablecloth thing again.
Nope. A math trick.
Oh yeah?
Pick a number, any number.
I can tell you whether your number is divisible by 9.
Okay. How about...
...seventy-two thousand, nine hundred forty-five.
72,945
Too easy. Pick a harder one.
Too *easy!?*
Sure. I don't even need to use my trick to see that 72,945 is divisible by 9.
You can just split 72,945 into 72,000+900+45.
72,945 = 72,000 + 900 + 45
How does this help us see that 72,945 is divisible by 9?



Since 72,000, 900, and 45 are all divisible by 9...
...so is 72,945.
72,945 = 72,000 + 900 + 45
=9×8,000 + 9×100 + 9×5
=9×(8,000+100+5)
WHEN WE ADD TWO OR MORE MULTIPLES OF A NUMBER, WE GET ANOTHER MULTIPLE OF THE SAME NUMBER. IN THE EXAMPLE ABOVE, ADDING THREE MULTIPLES OF 9 GIVES US ANOTHER MULTIPLE OF 9.
Neat.
How about...
...five million, five hundred thousand fifty?
Ooooh. Good one.
5,500,050
5,500,050 is *not* divisible by 9.
But 5,500,053 is.
Whoa! How can you tell?
To figure out if a number is divisible by 9, you just add all of its digits.
If the sum of a number's digits is divisible by 9, then the number is divisible by 9.
5,500,053
5+5+0+0+0+5+3=18 ✓
But, if the sum of the digits is *not* divisible by 9, then the number isn't divisible by 9.
5,500,050
5+5+0+0+0+5+0=15 X

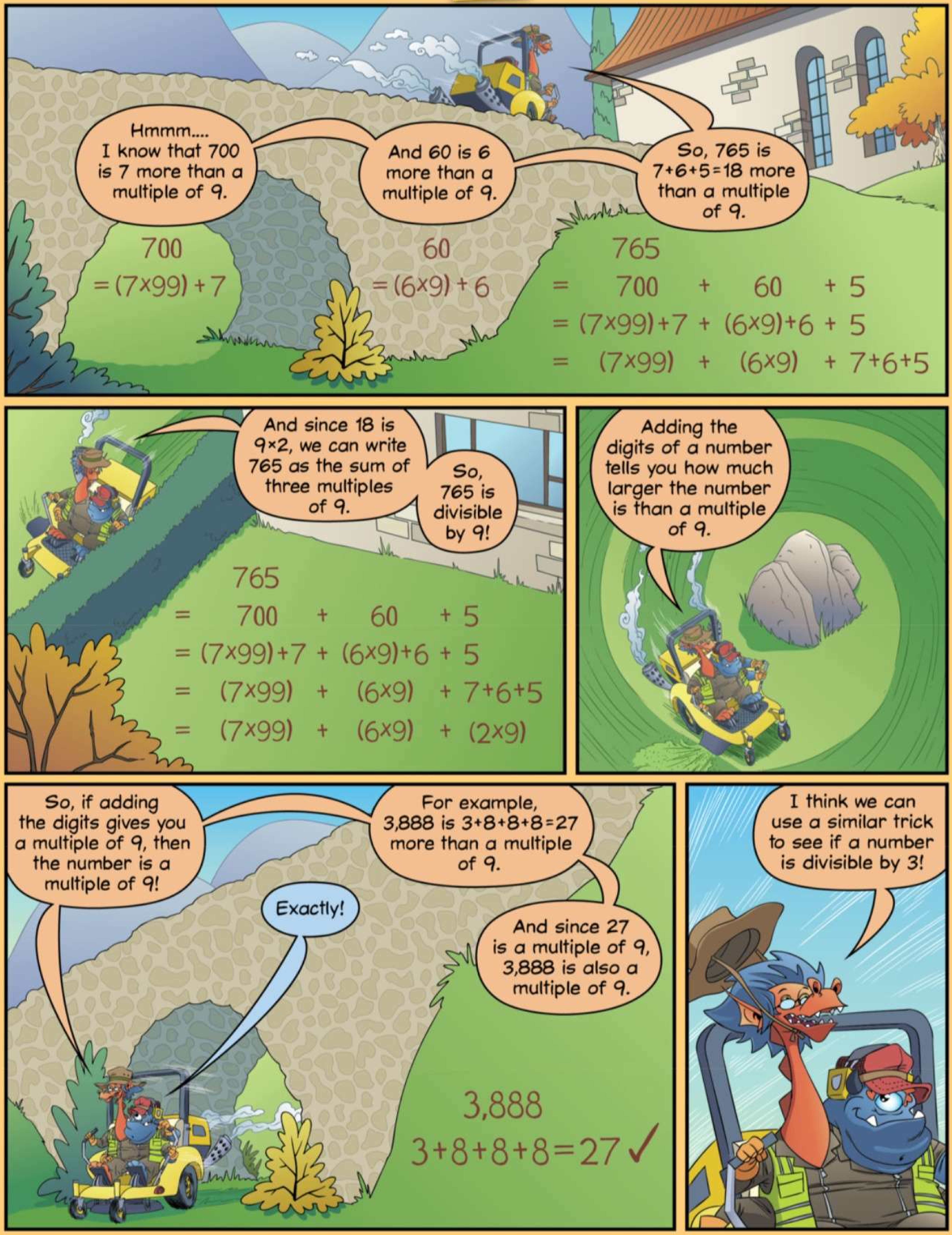

Why does ***that*** work?
That's the coolest part!
It's kind of tricky to explain.
First, you need to know a little bit about remainders.
What is the remainder when 10 is divided by 9?
1.
Right.
What is the remainder when 20 is divided by 9?
2.
How about 30?
3.
Good. Since ten leaves a remainder of 1 when divided by 9...
...dividing 2 tens by 9 leaves a remainder of 2...
...and dividing 3 tens by 9 leaves a remainder of 3.
What is the remainder when 70 is divided by 9?

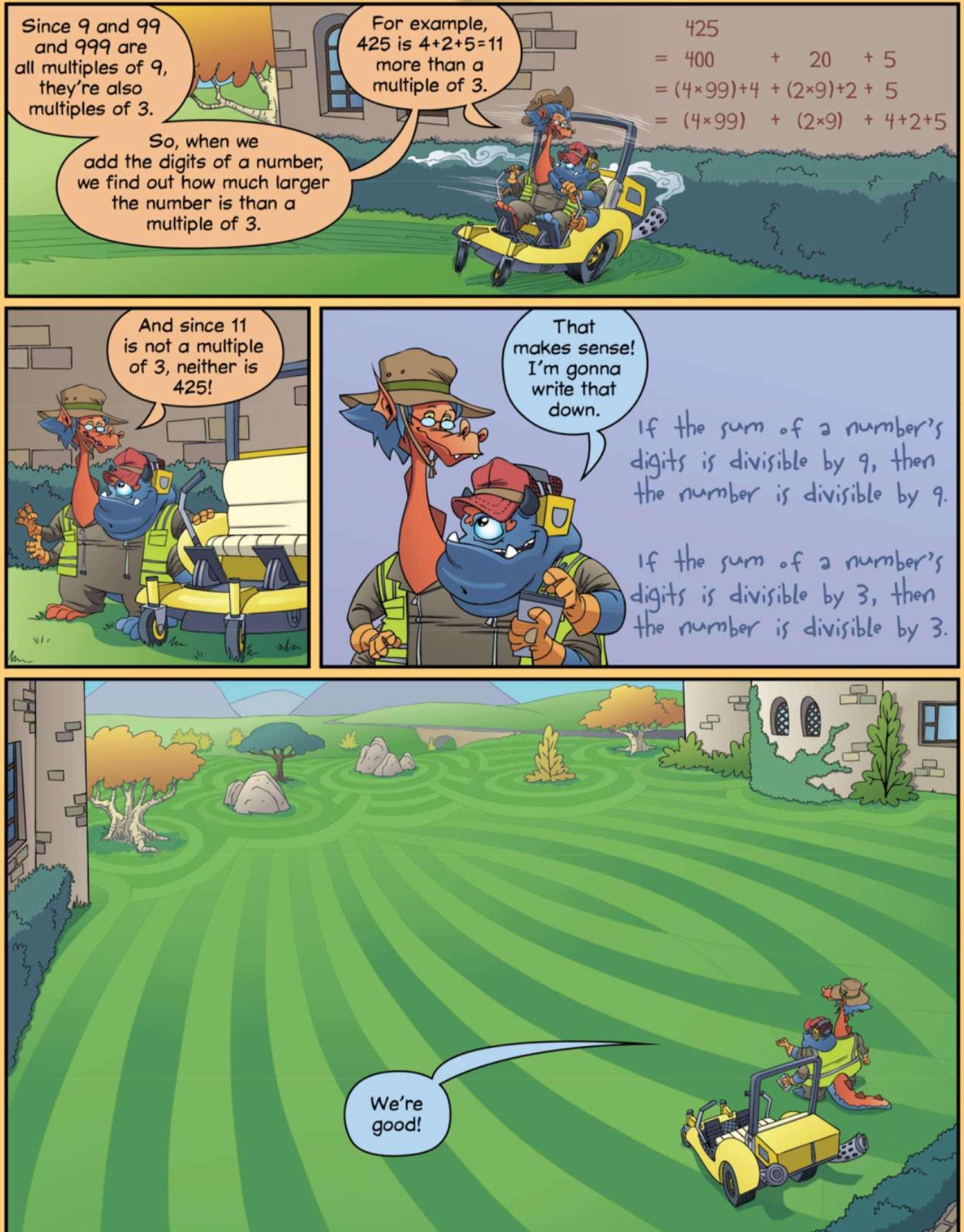

70 is seven 10's.
Each 10 gives us one 9 plus 1 extra.
That makes 7 extras.
So, 70÷9 has remainder 7.
You've got it. Next, let's try 100. What's the remainder when 100 is divided by 9?
7 extras
9+1
9+1
9+1
9+1
9+1
9+1
9+1
70
=7×10
=7×(9+1)
=(7×9)+(7×1)
=(7×9)+7
Well, since 9×11=99, 100 is 1 more than a multiple of 9.
So, 100÷9 has a remainder of 1.
Right. Now, what is the remainder when 700 is divided by 9?
I think I see where you're going with this.
700 is seven 100's.
Each 100 gives us one 99 plus 1 extra.
That makes 7 extras.
So, 700÷9 has remainder 7.
Yep.
Try 1,000.
What's the remainder when 1,000 is divided by 9?
99
7 extras
99+1
99+1
99+1
99+1
99+1
99+1
99+1
700
=7×100
=7×(99+1)
=(7×99)+(7×1)
=(7×99)+7

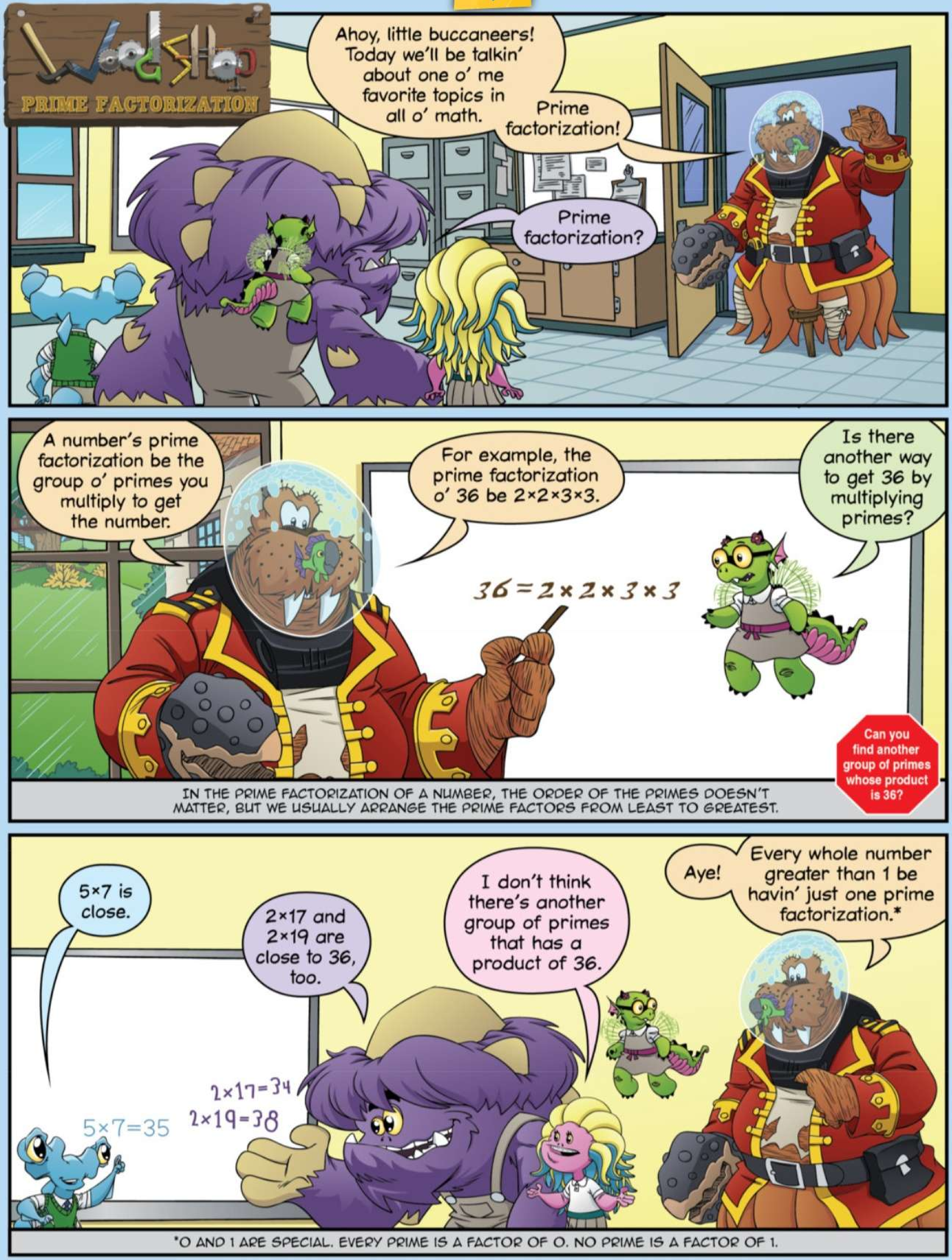


Well, since 9×111=999, we know that 1,000 is 1 more than a multiple of 9.
So, 1,000÷9 has a remainder of 1.
Right.
In fact, every power of 10 is 1 more than a multiple of 9!
10,000 is 1 more than 9,999.
100,000 is 1 more than 99,999.
And 1,000,000 is 1 more than 999,999.
Since 10 and 100 and 1,000,000 are each 1 more than a multiple of 9...
...70 and 700 and 7,000,000 are each 7 more than a multiple of 9!
So, 70 and 700 and 7,000,000 each leave a remainder of 7 when divided by 9.
70
=7×10
=7×(9+1)
=(7×9)+(7×1)
=(7×9)+7
700
=7×100
=7×(99+1)
=(7×99)+(7×1)
=(7×99)+7
7,000,000
=7×1,000,000
=7×(999,999+1)
=(7×999,999)+(7×1)
=(7×999,999)+7

It's easy to find the remainder when a number like 400 or 6,000 or 30,000 is divided by 9.
The remainder is the same as the first digit of the number.
400 = 4×100 = 4×(99+1) = 4×99 + 4
6,000 = 6×1,000 = 6×(999+1) = 6×999 + 6
30,000 =3×10,000 =3×(9,999+1) =3×9,999 + 3
Right. Now, try 504.
What's the remainder when 504 is divided by 9?
Hmmm.... I know that 500 is 5 more than a multiple of 9...
...so 504 is 5+4=9 more than a multiple of 9.
500 =5 × 100 =5 × (99+1) =(5×99)+(5×1) =(5×99) + 5
504 =(5 × 99 + 5) + 4 =(5 × 99) + 9
But, if we add 9 to a multiple of 9...
...we get the next multiple of 9!
So, 504 is divisible by 9!
Bingo! How about 765?
Is 765 divisible by 9?


Hmmm....
I know that 700 is 7 more than a multiple of 9.
And 60 is 6 more than a multiple of 9.
So, 765 is 7+6+5=18 more than a multiple of 9.
700
=(7×99)+7
60
=(6×9)+6
765
= 700 + 60 + 5
= (7×99)+7 + (6×9)+6 + 5
= (7×99) + (6×9) + 7+6+5
And since 18 is 9×2, we can write 765 as the sum of three multiples of 9.
So, 765 is divisible by 9!
765
= 700 + 60 + 5
= (7×99)+7 + (6×9)+6 + 5
= (7×99) + (6×9) + 7+6+5
= (7×99) + (6×9) + (2×9)
Adding the digits of a number tells you how much larger the number is than a multiple of 9.
So, if adding the digits gives you a multiple of 9, then the number is a multiple of 9!
For example, 3,888 is 3+8+8+8=27 more than a multiple of 9.
Exactly!
And since 27 is a multiple of 9, 3,888 is also a multiple of 9.
3,888
3+8+8+8=27 ✓
I think we can use a similar trick to see if a number is divisible by 3!


Since 9 and 99 and 999 are all multiples of 9, they're also multiples of 3.
For example, 425 is 4+2+5=11 more than a multiple of 3.
So, when we add the digits of a number, we find out how much larger the number is than a multiple of 3.
425
= 400 + 20 + 5
= (4×99)+4 + (2×9)+2 + 5
= (4×99) + (2×9) + 4+2+5
And since 11 is not a multiple of 3, neither is 425!
That makes sense! I'm gonna write that down.
If the sum of a number's digits is divisible by 9, then the number is divisible by 9.
If the sum of a number's digits is divisible by 3, then the number is divisible by 3.
We're good!

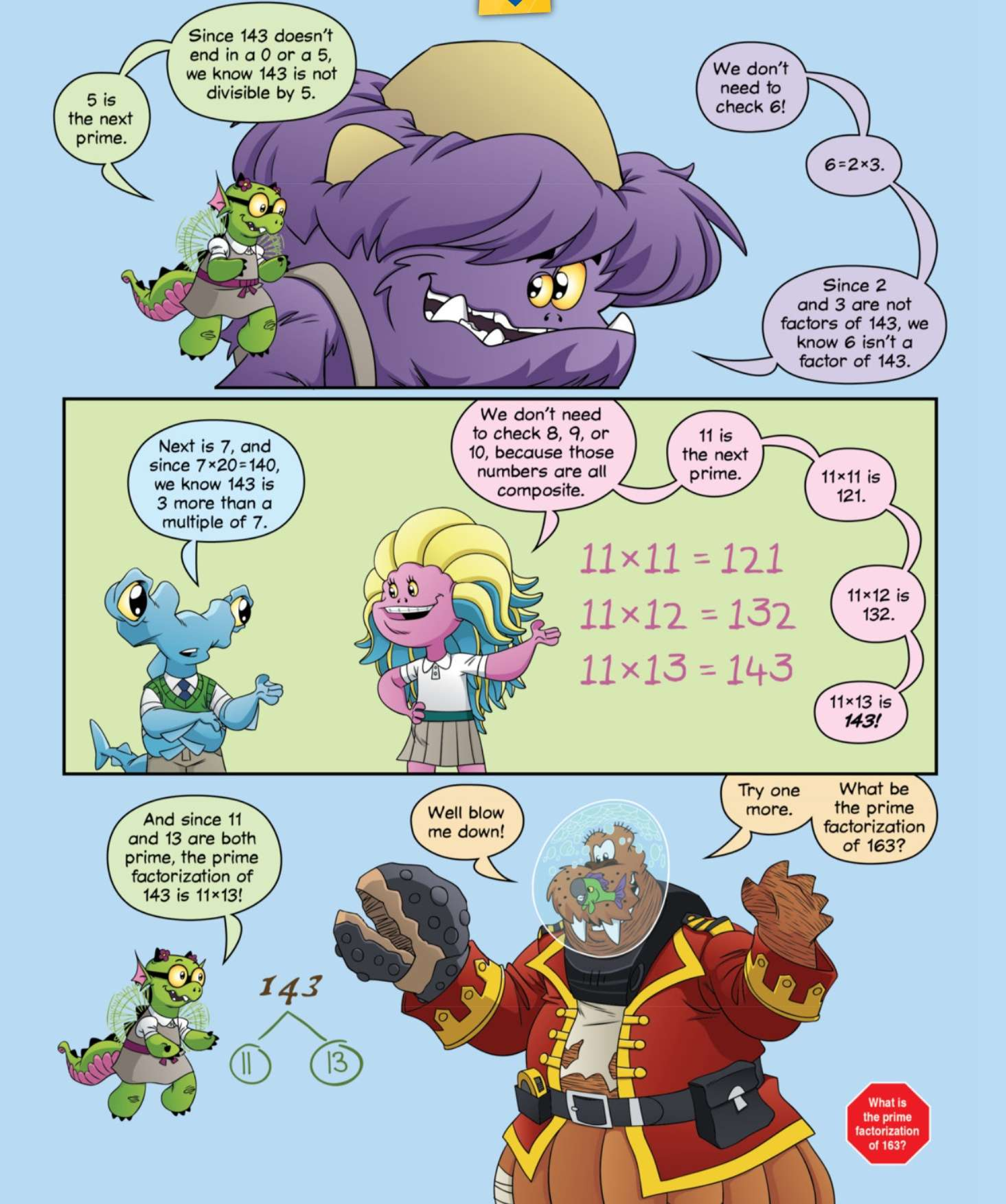

PRIME FACTORIZATION
Ahoy, little buccaneers! Today we'll be talkin' about one o' me favorite topics in all o' math.
Prime factorization!
Prime factorization?
A number's prime factorization be the group o' primes you multiply to get the number.
For example, the prime factorization o' 36 be 2×2×3×3.
36 = 2 × 2 × 3 × 3
Is there another way to get 36 by multiplying primes?
Can you find another group of primes whose product is 36?
IN THE PRIME FACTORIZATION OF A NUMBER, THE ORDER OF THE PRIMES DOESN'T MATTER, BUT WE USUALLY ARRANGE THE PRIME FACTORS FROM LEAST TO GREATEST.
5×7 is close.
2×17 and 2×19 are close to 36, too.
I don't think there's another group of primes that has a product of 36.
Aye!
Every whole number greater than 1 be havin' just one prime factorization.*
5×7=35
2×17=34
2×19=38
*0 AND 1 ARE SPECIAL. EVERY PRIME IS A FACTOR OF 0. NO PRIME IS A FACTOR OF 1.


How do we prime factorize a number?
To find the prime factorization of a number, we'll be usin' a factor tree.
"FACTORIZE" IS NOT A REAL WORD.
Does that mean we get to go outside?
It's not a ***real*** tree, Grogg!
A ***factor tree*** is a diagram that shows how a number can be broken into factors.
Aye. Let's use a factor tree to find the prime factorization o' 56.
56
First, we look for two numbers that have a product of 56.
Like 7×8?
Exactly.
We write the two factors below the 56, like this.
56
7
8
Can you guess what comes next?

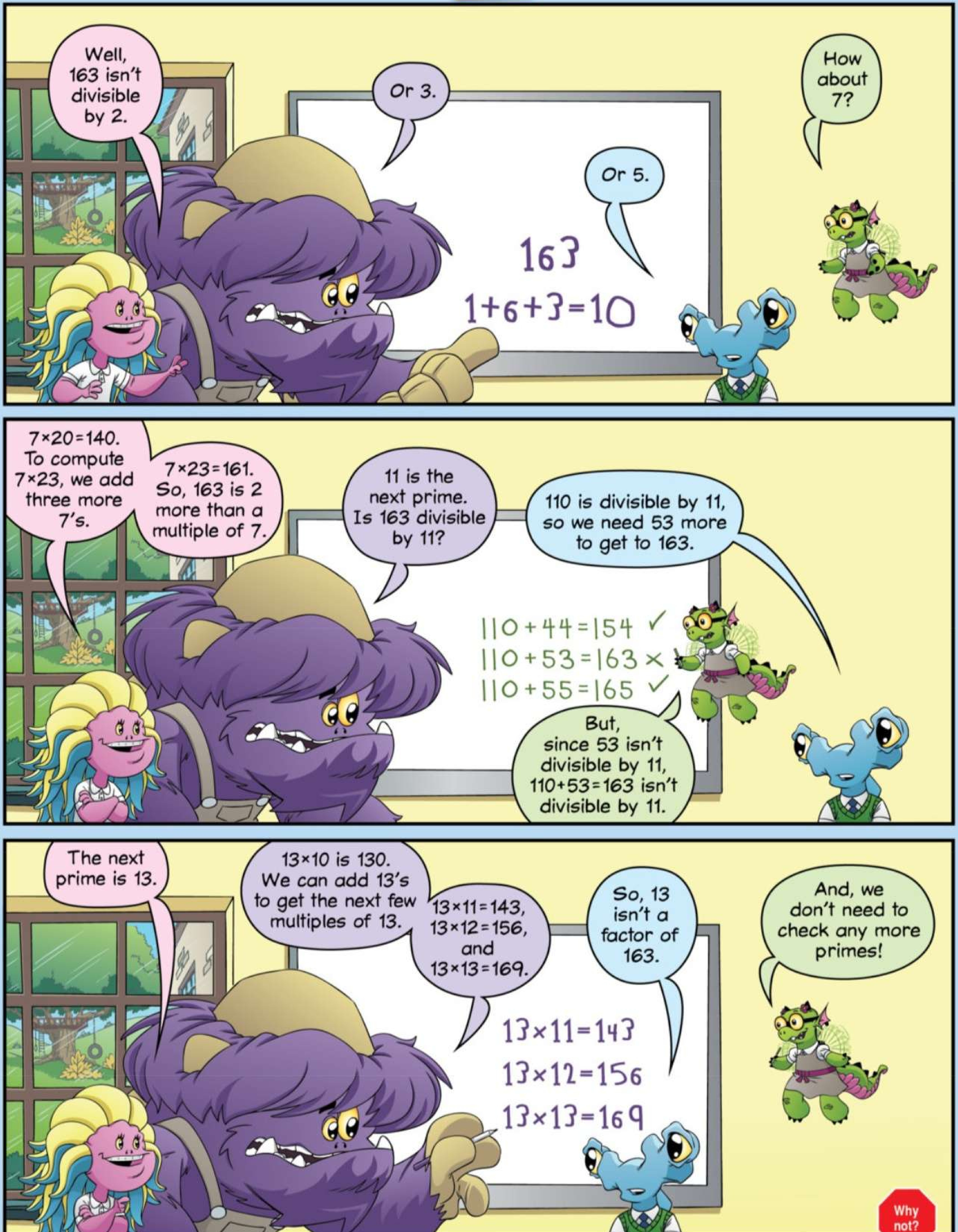

7 is prime, so we've already found one prime factor of 56.
Aye. We'll be circlin' the primes we find in our factor tree.
56
7 8
8 isn't prime. We can factor 8 into 4×2.
56
7 8
4 2
And since 2 is prime, we circle it!
Now you're gettin' the hang of it, lad!
56
7 8
4 2
Then, we can factor 4 into 2×2.
56
7 8
4 2
2 2
And we circle these two 2's because 2 is prime!
The circled numbers give us the prime factors of 56...
...three 2's and a 7.
Aye. We usually write the factors in order, like so.
56
7 8
4 2
2 2
56=2×2×2×7

Aren't there other ways to make a factor tree for 56? What if we start with 2×28?
56
2 28
There be many ways to make the tree, but the circled primes always be the same.
56
2 28
7 4
2 2
56=2×2×2×7
SOMETIMES, MATH BEASTS USE EXPONENTS TO WRITE PRIME FACTORIZATIONS. FOR EXAMPLE, 56=2×2×2×7=2³×7.
What if the number is prime? How do we write the prime factorization of a prime?
The prime factorization of a prime be just the prime number itself.
13
How do we **know** a number is prime?
Suppose we wanted to write the prime factorization of 123?
How can we tell if 123 is prime?
123
You'll be needin' to see if 123 has any factors, other than 1 and 123.
Start checkin' with 2, 'n' work your way up.
Since 123 is odd, we know that 2 is not a factor of 123.
What is the prime factorization of 123?

Since 1+2+3=6 is divisible by 3, 123 is divisible by 3.
3×40=120. So, 3×41=123!
123
3
41
And both 3 and 41 are prime, so our factor tree is done!
The prime factorization of 123 is 3×41.
123=3×41
WE LEARNED THAT 41 IS PRIME ON PAGE 29.
Aye. Good job. Try another. What be the prime factorization of 143?
143
143 is obviously not divisible by 2.
And since 1+4+3=8 is not divisible by 3, 143 isn't divisible by 3.
What about 4?
Grogg! Since 2 isn't a factor of 143, we already know 4 isn't a factor of 143.
Since 4 is 2×2, every number that has 4 as a factor also has 2 as a factor.
We only need to check for ***prime*** factors.



5 is the next prime.
Since 143 doesn't end in a 0 or a 5, we know 143 is not divisible by 5.
We don't need to check 6!
6=2×3.
Since 2 and 3 are not factors of 143, we know 6 isn't a factor of 143.
Next is 7, and since 7×20=140, we know 143 is 3 more than a multiple of 7.
We don't need to check 8, 9, or 10, because those numbers are all composite.
11 is the next prime.
11×11 is 121.
11×11 = 121
11×12 = 132
11×13 = 143
11×12 is 132.
11×13 is ***143!***
And since 11 and 13 are both prime, the prime factorization of 143 is 11×13!
143
11
13
Well blow me down!
Try one more.
What be the prime factorization of 163?
What is the prime factorization of 163?


Well, 163 isn't divisible by 2.
Or 3.
Or 5.
How about 7?
163
1+6+3=10
7×20=140. To compute 7×23, we add three more 7's.
7×23=161. So, 163 is 2 more than a multiple of 7.
11 is the next prime. Is 163 divisible by 11?
110 is divisible by 11, so we need 53 more to get to 163.
110+44=154 ✓
110+53=163 ×
110+55=165 ✓
But, since 53 isn't divisible by 11, 110+53=163 isn't divisible by 11.
The next prime is 13.
13×10 is 130. We can add 13's to get the next few multiples of 13.
13×11=143, 13×12=156, and 13×13=169.
13×11=143
13×12=156
13×13=169
So, 13 isn't a factor of 163.
And, we don't need to check any more primes!
Why not?

Since 13×13=169, any number that is larger than 13 has to be multiplied by a number that's smaller than 13 to get 163.
163 is prime!
So, 163 doesn't have any factors besides 1 and 163.
The prime factorization of 163 is just 163.
Excellent figurin'!
You've earned yourselves a break.