

Girls in Math at Yale 2024 Lightning Finals

Yale Math Competitions

Sample Question

The area of an equilateral triangle with sides of length 12 is how many times the area of an equilateral triangle with sides of length 8?

Sample Question

The area of an equilateral triangle with sides of length 12 is how many times the area of an equilateral triangle with sides of length 8?

Answer: $\frac{9}{4}$ or 2.25

Note: Answers can be in any form, not just integers. However, a correct answer must be in simplest form in order to receive credit.

Question 1

There are 99 boxes, numbered from 1 to 99. Tiffany the Turtle opens every non-prime box and then closes every square box. How many boxes are closed afterwards?

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Answer:

Question 2

Travis the Tortoise is bored. He decides to list all numbers less than 10312 that are primes and also squares. How many numbers does he have to list?

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Answer:

Question 3

Onto his next endeavor, Travis then computes the probability that a non-degenerate triangle with side lengths 3, 4, and x , with x uniformly distributed has all three of its altitudes in the interior of the triangle. What is this probability?

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Onto his next endeavor, Travis then computes the probability that a non-degenerate triangle with side lengths 3, 4, and x , with x uniformly distributed has all three of its altitudes in the interior of the triangle. What is this probability?

Answer: $\frac{5 - \sqrt{7}}{6}$

Question 4

Travis heads to Taylor the Turtle's concert, planning to meet up with his friend, Tim. Travis will arrive at a random time between 8 and 9 PM. Tim will definitely arrive at a random time between 8 and 9 PM as well, but Tim will definitely not arrive between 8:15 and 8:45. They will only wait 10 minutes for each other. What is the probability they meet?

Question 4

Travis heads to Taylor the Turtle's concert, planning to meet up with his friend, Tim. Travis will arrive at a random time between 8 and 9 PM. Tim will definitely arrive at a random time between 8 and 9 PM as well, but Tim will definitely not arrive between 8:15 and 8:45. They will only wait 10 minutes for each other. What is the probability they meet?

Answer: $\frac{5}{18}$

Question 5

Tina the Terrapin is thinking about quotients. Find

$$\frac{11 \times 10 \times 9 \times 8 \times 7}{6 \times 5 \times 4 \times 3 \times 2 \times 1}$$

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$$\frac{11 \times 10 \times 9 \times 8 \times 7}{6 \times 5 \times 4 \times 3 \times 2 \times 1}$$

Answer:

Question 6

Tina the Terrapin is thinking about terminating t decimals. How many positive t decimals tinier than one end before the ten-thousandths digit and has a 1000 in its reduced fractional form's denominator?

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Answer:

Question 7

On a certain day, Tina the Terrapin ran at an average speed of 75 miles per hour on the way to work. On the return trip along the same path, she experienced a turtle jam and walked at an average speed of 15 miles per hour. What is her average speed, in miles per hour, for the round trip?

Question 7

On a certain day, Tina the Terrapin ran at an average speed of 75 miles per hour on the way to work. On the return trip along the same path, she experienced a turtle jam and walked at an average speed of 15 miles per hour. What is her average speed, in miles per hour, for the round trip?

Answer:

Question 8

Troy, Turtle King of Troy, plans a prank. He fills a regular hexagonal water balloon of side length 2. The splash zone for this balloon is anywhere that is within 1 from the hexagon. What is the area of the splash zone (including the hexagonal balloon itself)?

Question 8

Troy, Turtle King of Troy, plans a prank. He fills a regular hexagonal water balloon of side length 2. The splash zone for this balloon is anywhere that is within 1 from the hexagon. What is the area of the splash zone (including the hexagonal balloon itself)?

Answer: $12 + 6\sqrt{3} + \pi$

Question 9

Todysseus is seeking revenge on Troy. He builds a Trojan Turtle made out of a hemisphere placed on a unit cube. Given that the circular face of the hemisphere is contained entirely in one face of the cube, what is the maximum volume of this Trojan Turtle?

Question 9

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Answer: $1 + \frac{\pi}{12}$

Question 10

Todysseus must now appease the Turtle gods by correctly answering the Turtle Guardian™'s riddle. Three distinct prime numbers p , q , and r sum to 48. If $p < q < r$, what is the smallest possible value of $r - q$?

Question 10

Todysseus must now appease the Turtle gods by correctly answering the Turtle Guardian™'s riddle. Three distinct prime numbers p , q , and r sum to 48. If $p < q < r$, what is the smallest possible value of $r - q$?

Answer:

Question 11

Terence Taortle teaches "Trigonometry Techniques." Taking the tangent of ten times T totals three minus two. Then, what is the minimum possible positive T (in radians)?

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Answer: $\frac{\pi}{40}$

Question 12

The Turtle Tri-Kingdom is trying to build Mt. Shellmore to display the ten most prominent turtles throughout history in a line. Each of the three kingdoms will nominate three candidates, with the last spot going to any one of the three kingdoms. How many ways could the spots be allocated along the monument? (Spots allocated to the same kingdom are indistinguishable).

Question 12

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Answer:

Question 13

Tiana the Turtle is packing a infinitely-thin straight twig of length 20 in a cylindrical tin of radius 8. What is the minimum necessary height of the tin?

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Answer:

Question 14

Tiana the Turtle ships a tin via Turtle Prime. Turtle Prime guarantees that the package will be shipped in a random prime number of days within 30 days, but Tiana needs the package to arrive within 14 days in time for Tina the Terrapin's birthday. What's the probability it'll arrive in time?

Question 14

Tiana the Turtle ships a tin via Turtle Prime. Turtle Prime guarantees that the package will be shipped in a random prime number of days within 30 days, but Tiana needs the package to arrive within 14 days in time for Tina the Terrapin's birthday. What's the probability it'll arrive in time?

Answer:

$$\frac{3}{5}$$

Question 15

On Tina's birthday, she opens the tin to find the 20-length twig! Overjoyed, she takes it outside, where she notices that when held vertically it casts a shadow of length $\frac{20}{\sqrt{3}}$. Assume the sun is very far away - then at what angle, in radians, from the vertical is it?

Question 15

On Tina's birthday, she opens the tin to find the 20-length twig! Overjoyed, she takes it outside, where she notices that when held vertically it casts a shadow of length $\frac{20}{\sqrt{3}}$. Assume the sun is very far away - then at what angle, in radians, from the vertical is it?

Answer:

Question 16

Stephen has been forced into making the GiM logo. Being new at Photoshop, he normally would be able to finish the task in three hours. However, Neil and Cindy are busy distracting him, reducing his productivity by 50% for half of the total duration. How long, in hours, does it take for him to finish the logo?

Question 16

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Answer:

Question 17

Tsinghua the Turtle is taking a very long test. On this test, there are 40 problems, each of which must be answered true or false. A correct answer earns 1 point and a wrong answer loses 0.5 points. What is the smallest positive unobtainable integer score?

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Answer:

Question 18

Tsinghua the Turtle is taking a true/false exam. He flips a fair coin to decide the answer, and earns i points for the i th problem if correct (0 for wrong answers). What is the expected value of the number of points he'll have after 10 questions?

Question 18

Tsinghua the Turtle is taking a true/false exam. He flips a fair coin to decide the answer, and earns i points for the i th problem if correct (0 for wrong answers). What is the expected value of the number of points he'll have after 10 questions?

Answer: $\frac{55}{2}$

Question 19

Tsinghua the Turtle is struggling with the final question on this exam. He needs to generate a quadratic $ax^2 + bx + c$ that has two distinct integer roots, so he does this by rolling a 3-sided die three times to generate a, b, c . What is the probability that he succeeds?

Question 19

Tsinghua the Turtle is struggling with the final question on this exam. He needs to generate a quadratic $ax^2 + bx + c$ that has two distinct integer roots, so he does this by rolling a 3-sided die three times to generate a, b, c . What is the probability that he succeeds?

Answer: $\frac{2}{27}$

Question 20

Terry the Tortoise is telling the time. How many days are in $12!$ seconds?

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Answer:

Question 21

Terry the Tortoise is done patiently waiting. He descends into his underground lair, which is a spiral staircase that wraps around a cylindrical hole of radius $\frac{8}{\pi}$ and height 100. He makes 6.25 full revolutions on the way down - how far did he walk?

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Terry the Tortoise is done patiently waiting. He descends into his underground lair, which is a spiral staircase that wraps around a cylindrical hole of radius $\frac{8}{\pi}$ and height 100. He makes 6.25 full revolutions on the way down - how far did he walk?

Answer:

Question 22

Four turtles carrying the numbers 2, 0, 2, 4 randomly shuffle themselves and then arrange themselves into a line. What is the expected value of the four-digit number formed?

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Answer:

Question 23

Trapp and Thomas the Turtles both think of an integer between 1 and 20 inclusive. What is the probability that the difference of the squares of their numbers is divisible by 17?

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Trapp and Thomas the Turtles both think of an integer between 1 and 20 inclusive. What is the probability that the difference of the squares of their numbers is divisible by 17?

Answer: $\frac{11}{200}$

Question 24

There are 2024 green turtles in a pond. Every turtle has a 10% chance of turning yellow each day. After 2 days, what's the probability that a randomly chosen turtle is yellow?

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Answer:

Question 25

Oogway the Turtle ate a lot of food, and ballooned up to the shape of a sphere of radius 6. Shifu the Turtle didn't eat that much and stayed in the shape of a hemisphere of radius 6. How much more 'turtle' is in Oogway than Shifu?

Question 25

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Answer:

Question 26

It is well known that turtles like logs. What is $\log_{16}(2^{20} \times 4^{40} \times 8^{80})$?

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It is well known that turtles like logs. What is $\log_{16}(2^{20} \times 4^{40} \times 8^{80})$?

Answer:

Question 27

Tony the Turtle is done taking his bath. It takes 12 minutes to fill an empty bathtub when the faucet is turned on and the drain is left unplugged. When the drain is plugged, it only takes 8 minutes. The bathtub is currently full and the faucet is off. How long does it take to empty?

Question 27

Tony the Turtle is done taking his bath. It takes 12 minutes to fill an empty bathtub when the faucet is turned on and the drain is left unplugged. When the drain is plugged, it only takes 8 minutes. The bathtub is currently full and the faucet is off. How long does it take to empty?

Answer:

Question 28

Tiana the Turtle has the numbers 2, 3, 4 and assigns one number to each of the variables x, y, z . What is the maximum value of $x^y + z$?

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Answer:

Question 29

Timothy the Terrapin has a five-digit integer \underline{ABCDE} whose digits are in strictly ascending order. The digits satisfy the following conditions; A and E are prime, C is a square and D is even. What is the number?

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Answer:

Question 30

Tom and Tim the Turtles are standing on the beach at some point on the circumference of a circle of radius 8. They both pick a direction and run in a straight line until they reach the other end. Tom runs a distance of 6 and Tim runs a distance of 10. They both leave a trail in the sand, and Tim's trail intersects the middle of Tom's trail. What is the minimum possible distance Tim runs before the intersection point?

Question 30

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Answer:

Question 31

Tom and Tim the Turtles are both of size 1. Whenever a turtle eats an apple, they multiply their size by 3, and whenever they eat a strawberry, they multiply their size by 6. Every minute, Tom gets an apple and Tim gets a strawberry. How much time elapses before Tim is 4^5 times bigger than Tom?

Question 31

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Answer:

Question 32

How many ways can Tiffany the Turtle pick a number that divides 360 but not 180?

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Answer:

Question 33

Two years ago, Tiffany was 3 times as old as Tina. Three years from now, Tiffany will be 2 times as old as Tina. How old will Tiffany be when Tina reaches Tiffany's current age?

Question 33

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Answer:

Question 34

Tom (a turtle) and Jerry (a tortoise) are running a race. They are at $(0, 0)$ and want to reach $(54, 0)$. There are two square ponds of edge length 10 centered at $(17, 0)$ and $(37, 0)$, parallel to the axes. Tom will travel in a straight line, swimming if necessary (on land, he goes at 6 miles per hour). Jerry will travel the shortest path, but only on land, at 8 miles per hour. How fast does Tom need to swim to tie the race?

Question 34

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Answer:

Question 35

Tina picks a vertex of a 2024-gon and draws all possible diagonals from that vertex, splitting the polygon into 2022 triangles. How many of these triangles are acute?

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Answer:

Question 36

A new species of bacturtlia doubles every 2 hours. A petri dish of bacturtlia starts with a population of 1000, and after 6 hours disinfectant is applied, reducing the population by 99.9 percent. How many remain?

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Answer:

Question 37

Alice and Bob are playing Battle Turtles. Each player gets 3 battle turtles to distribute across Ponds 1, 2, and 3. Alice distributes (1, 1, 1). Each turtle must be allocated to exactly one pond. Whoever has more turtles in a pond wins control of the pond (tied ponds go to nobody). What's the probability that they each control exactly one pond if Bob distributes each turtle to a random pond?

Question 37

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Answer:

$$\frac{2}{3}$$

Question 38

In Battle Turtles 2, the player must try and contain all the runaway turtles. You know the 6 runaway turtles are on the Cartesian plane and are the vertices of a regular unit hexagon, with one turtle at $(1, 0)$. You place one fence-post at $(1, 0)$, and you can place 3 more anywhere you'd like. What is the minimum possible area of the quadrilateral formed by your fenceposts, if every turtle must be inside them?

Question 38

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Answer:

Question 39

In Battle Turtles 3, Alice has 30 indistinct nano-turtles. How many ways can she distribute 30 nano-turtles across 5 distinct moats, given that she needs to have at least 4 nano-turtles in each moat to survive the zombie-turtle apocalypse?

Question 39

In Battle Turtles 3, Alice has 30 indistinct nano-turtles. How many ways can she distribute 30 nano-turtles across 5 distinct moats, given that she needs to have at least 4 nano-turtles in each moat to survive the zombie-turtle apocalypse?

Answer:

Question 40

Tina wants to buy copies of Battle Turtles for her friends. She has 50 Turtlecoin, and Battle Turtles 1, 2, and 3 cost 5, 7, and 13 Turtlecoin respectively. The newer versions bring more happiness to her friends, with the three versions giving 2, 3, and 4 happiness respectively. What is the most happiness she can obtain?

Question 40

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Answer:

Question 41

Tilly Wonka the Turtle has two circular candies O_1 and O_2 that have radii r_1 and r_2 respectively. If a 74° arc on O_1 has the same length as a 111° arc on O_2 , what is the ratio of the area of O_1 to the area of O_2 ?

Question 41

Tilly Wonka the Turtle has two circular candies O_1 and O_2 that have radii r_1 and r_2 respectively. If a 74° arc on O_1 has the same length as a 111° arc on O_2 , what is the ratio of the area of O_1 to the area of O_2 ?

Answer: $\frac{9}{4}$

Question 42

Tayush the Turtle finds the smallest and largest r such that $\frac{x^2}{16} + \frac{y^2}{25} = r$ intersects with $\frac{x^2}{25} + \frac{y^2}{16} = 1$. What is the difference between these two values?

Question 42

Tayush the Turtle finds the smallest and largest r such that $\frac{x^2}{16} + \frac{y^2}{25} = r$ intersects with $\frac{x^2}{25} + \frac{y^2}{16} = 1$. What is the difference between these two values?

Answer:

$$\frac{369}{400}$$

Question 43

Teil, Tindy, and Tarwin (who are obviously all turtles) are playing Three-Player Tchess. They take turns (in this order) placing bishops on the 9 by 9 board. (Bishops can attack any square on its diagonal). If they manage to cram the most bishops as possible on the board such that no two bishops attack each other, who placed the last bishop?

Question 43

Teil, Tindy, and Tarwin (who are obviously all turtles) are playing Three-Player Tchess. They take turns (in this order) placing bishops on the 9 by 9 board. (Bishops can attack any square on its diagonal). If they manage to cram the most bishops as possible on the board such that no two bishops attack each other, who placed the last bishop?

Answer:

Question 44

Tina the Turtle gathers 15 sticks of length $1, 2, \dots, 15$ and adds their lengths to get t units. Tiana the Terrapin gathers 15 cubic apples of side lengths $1, 2, \dots, 15$ and adds their volumes to get t' cubic units. What is $\frac{t'}{t}$?

Question 44

Tina the Turtle gathers 15 sticks of length $1, 2, \dots, 15$ and adds their lengths to get t units. Tiana the Terrapin gathers 15 cubic apples of side lengths $1, 2, \dots, 15$ and adds their volumes to get t' cubic units. What is $\frac{t'}{t}$?

Answer:

Question 45

Tina the Turtle and Tiana the Terrapin both start at the same location and race toward a goal post that is one mile away. Tina runs at a constant speed of 40 miles per hour, and Tiana runs at a constant speed of 60 miles per hour. How many seconds after Tiana passes the goal post will Tina pass the goal post?

Question 45

Tina the Turtle and Tiana the Terrapin both start at the same location and race toward a goal post that is one mile away. Tina runs at a constant speed of 40 miles per hour, and Tiana runs at a constant speed of 60 miles per hour. How many seconds after Tiana passes the goal post will Tina pass the goal post?

Answer:

Question 46

James has a Giant Turtle that currently is size 1. James can either feed his Giant Turtle a Giant Peach or a Regular Peach which multiplies its size by either 3 or 2 at a given step until the size reaches exactly 216. What is the sum of all the possible distinct sizes the turtle could be throughout this process?

Question 46

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Answer:

Question 47

Define the function $\text{Turtle}(a, b) = 3a^2 + kb^2$ for some constant k . It is known that $\text{Turtle}(-2, 5) = 262$. What is k ?

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Answer:

Question 48

Trevor the Turtle evaluates $\frac{1}{4 + \frac{1}{3 + \frac{1}{2 + \frac{1}{1}}}}$ and Tim the Turtle subtracts 1 from Trevor's number. What does Tim get?

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Trevor the Turtle evaluates $\frac{1}{4 + \frac{1}{3 + \frac{1}{2 + \frac{1}{1}}}}$ and Tim the Turtle subtracts 1 from Trevor's number. What does Tim get?

Answer:

$$\frac{-33}{43}$$

Question 49

Trevor the tired turtle has an exam the next day. He sets four alarms that go off in the morning. Starting from 8 o'clock, the first alarm sounds every 2 minutes, the second alarm every 4 minutes, the third alarm every 6 minutes, and the fourth alarm every 8 minutes. If the alarms all sound at 8 o'clock, when is the next time they will all sound?

Question 49

Trevor the tired turtle has an exam the next day. He sets four alarms that go off in the morning. Starting from 8 o'clock, the first alarm sounds every 2 minutes, the second alarm every 4 minutes, the third alarm every 6 minutes, and the fourth alarm every 8 minutes. If the alarms all sound at 8 o'clock, when is the next time they will all sound?

Answer:

Question 50

Treehugger the turtle has 4 red pencils and 4 blue pencils in a basket. In how many ways can Treehugger draw pencils from the basket, one at a time until the basket is empty, if pencils of the same color are indistinguishable?

Question 50

Treehugger the turtle has 4 red pencils and 4 blue pencils in a basket. In how many ways can Treehugger draw pencils from the basket, one at a time until the basket is empty, if pencils of the same color are indistinguishable?

Answer:

Question 51

At a pizza party, there are a new generation of Teenage Mutant Ninja Turtles spread across 9th, 10th, 11th, and 12th grade. Every turtle in 9th and 10th grade consumes 2 slices of pizza, while every turtle in 11th and 12th grade consumes 3 slices of pizza. If there are 200 total turtles split evenly between the four grades, how many slices of pizza are consumed by all the Teenage Mutant Ninja Turtles?

Question 51

At a pizza party, there are a new generation of Teenage Mutant Ninja Turtles spread across 9th, 10th, 11th, and 12th grade. Every turtle in 9th and 10th grade consumes 2 slices of pizza, while every turtle in 11th and 12th grade consumes 3 slices of pizza. If there are 200 total turtles split evenly between the four grades, how many slices of pizza are consumed by all the Teenage Mutant Ninja Turtles?

Answer:

Question 52

A *size n Turtle Cube* is a cube-shaped puzzle, formed from a n -by- n -by- n cube of unit cubes. The time that it takes Tracy the turtle to solve a size n Turtle Cube is proportional to the number of unit cubes appearing on its surface. If it takes Tracy 28 seconds to solve a size 4 Turtle Cube, how many seconds does it take Tracy to solve a size 5 Turtle Cube?

Question 52

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Answer:

Question 53

Timberland the turtle is going shopping, and notices that a leather jacket in a store is normally priced at 50 dollars, but is on clearance and being sold at a 20% discount. Timberland comes back the next week during a sale, and notices that another 20% discount is applied to the jacket's clearance price. A week later, however, Timberland noticed that the sale ended and the jacket's price had increased by 40 percent since last week. What is the positive difference, in dollars, between the jacket's final and original prices?

Question 53

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Answer:

Question 54

Two dark chocolate turtles and five white chocolate turtles together contain 194 calories, while four dark chocolate turtles and one white chocolate turtle together contain 145 calories. How many calories are in one white chocolate turtle?

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Answer:

Question 55

Terry the tortoise and Perry the porpoise share 128 pieces of candy. Terry gives Perry $\frac{4}{7}$ of his candy. After receiving Terry's candy, Perry gives $\frac{1}{5}$ of his candy. Now, both Terry and Perry have equal amounts of candy. How many pieces of Candy did Terry start with?

Question 55

Terry the tortoise and Perry the porpoise share 128 pieces of candy. Terry gives Perry $\frac{4}{7}$ of his candy. After receiving Terry's candy, Perry gives $\frac{1}{5}$ of his candy. Now, both Terry and Perry have equal amounts of candy. How many pieces of Candy did Terry start with?

Answer:

FINAL QUESTION

How many distinct turtle names have been used?

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