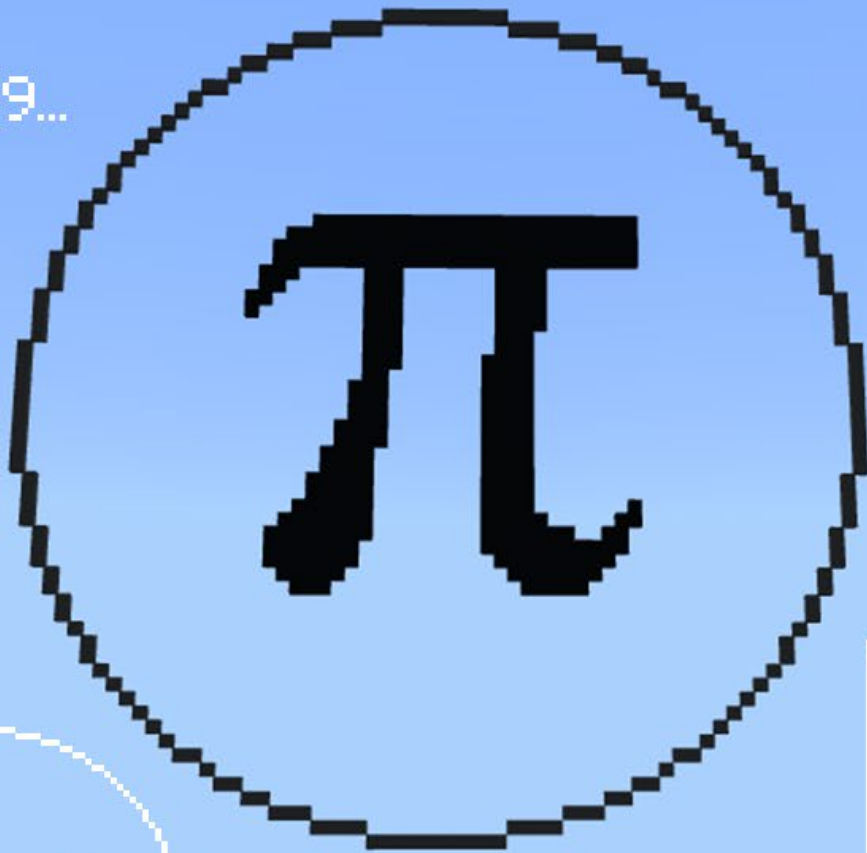


MINECRAFT EDUCATION

PI CRAFT

3.14159...



$\frac{22}{7}$



$V = \pi \cdot r^2 \cdot h$



A student workbook for Minecraft players, aged 8-14.

What is this resource?

- This is a student workbook, designed to help students aged 8-14 who want to learn about Pi using Minecraft.
- It is a series of 4 individual lessons and exercises, that build understanding of the wonder of Pi, while building in Minecraft. In the final lessons students will do some coding, but do not have to know how to code.
- At the end of this resource are lesson plans to help teachers and educators use this resource.
- Some of these lessons will work on Minecraft Java, Minecraft Bedrock, or Minecraft Education. The coding lessons require Minecraft Education.

How do I get Minecraft Education?

- Go to the Get [Minecraft Education download page](#).
- Select the version of Minecraft Education that is compatible with your device and download it.
- Install the version of Minecraft Education that you downloaded.
- Launch Minecraft Education.

If you are a user in a Microsoft-verified academic organization with Microsoft 365 accounts, you have access to a free trial for Minecraft Education. Otherwise, you will need to purchase Minecraft Education licenses. You can get more information about purchasing Minecraft Education from [here](#).

How do I get help if I am new to Minecraft?

- There is a quick start guide for teachers [here](#).
- There are a series of short videos on using Minecraft Education [here](#).

Section 1: Introduction

Math might make you think of just learning lots of formulas and doing problems like addition, subtraction, multiplication, and division. But imagine if English class was only about learning grammar rules and not about reading awesome stories! Can you imagine that math has its own hidden treasures just waiting for us to find them?

Math is full of cool stories and has grown from people being super creative over many, many years.

If you love playing games, you know that the best part is the challenge they bring. Beating a tough level or solving a tricky puzzle is what makes gaming fun. Math is kind of like a game too. It might seem tricky at first, but finding out all the neat things in math is super rewarding.

Let's go on an adventure together to uncover all the fun and amazing secrets hidden in the world of math! Along the way, you can also learn coding with MakeCode in Minecraft. How cool is that!

Mathematics' Grand Dual Purposes

Math is like a superpower for your brain! It starts with using your imagination and thinking in a clear, step-by-step way. When you get good at math, you become a super thinker who can solve all kinds of puzzles and problems, not just in math class, but in other subjects like science, history, and even music! Long ago, people thought math was a kind of magic that helped you think better about everything.

Here's a cool story: Abraham Lincoln, who was a very important president, loved math too! He was really into a special kind of math called geometry, which is all about shapes and spaces. He even carried a math book called "Elements" around to practice making his thinking skills stronger.

And guess what? Math is like a secret code that helps scientists and explorers understand the world and the stars. If you're curious about how things work, from the smallest bug to the biggest galaxy, math helps you unlock all those mysteries.

If you would like to learn more about the power and beauty of mathematics, we suggest this [video](#) (12 min) by William Travertti.

So, let's begin our journey of discovering the beauty of mathematics by gaining a deeper understanding of the number Pi.

Curves are Everywhere.

When you're outside playing or just looking around, you might notice that most things aren't made up of straight lines. Instead, they're curvy or round, like the shape of a tree, a soccer ball, or even how the moon travels around the Earth. It's rare to find things in nature that are just straight and pointy.

Now, let's chat about a cool math thing called "Pi." Pi is this special number that helps us understand all those round and curvy shapes you see. Think of it as a secret key that unlocks the mysteries of circles and curves everywhere.

Imagine you're putting together a puzzle and there's one piece you need to complete the picture. Pi is kind of like that missing piece, but for figuring out round things in the world. With Pi, scientists can figure out stuff like the size of a circle or how big the Earth is.

So, you can think of Pi as a magical tool, almost like a treasure map that guides us to understand the curvy and round shapes in nature. Just like explorers used the Rosetta Stone to decode ancient languages, we use Pi to decode the language of curves and circles around us. Isn't that awesome?

Pi is Irrational.

Imagine you're counting your video games or how many years old you are. We usually use whole numbers for that, right? But some numbers can be split into smaller pieces, kind of like sharing a candy bar. For example, the number 1 is like having one whole candy bar to yourself, which we can write as $1/1$.

Pi is like a magic key that helps us know the size of circles, from tiny ones to huge ones. We figure out Pi by measuring around the circle and then across it, from one side to the other.

But here's the wild part: Pi can't be broken down into a simple piece of the candy bar like most numbers. Even if you try to write it down as a fraction, like $1/2$ or $3/4$, it just doesn't work perfectly. Pi keeps going on and on with its numbers after the dot, and it never, ever stops or repeats.

Imagine you had a round pizza. If Pi was a simple number, you could easily say, "I ate $1/4$ of the pizza." But with Pi, it's like trying to slice the pizza into endless pieces, and the slices just keep getting smaller and never end.

So, when we say Pi is an "irrational number," it's like saying it's a puzzle that keeps going forever without repeating. It's a bit of a brain teaser! But even though Pi is mysterious, it's important for understanding all things round and curvy, like wheels, balls, and yes, even pizzas!

What is Pi?

Imagine you have a perfectly round cookie. If you use a piece of string to go all the way around the edge of the cookie, that's what we call the "**circumference**." Now, if you measure straight across the cookie through the center, that's the "**diameter**."

No matter how big or small the cookie is, if you divide the length of the circumference (or 'C') by the diameter (or 'd'), you *always* get the same magic number. That magic number is called "pi" or π , and it's a little more than 3 and close to 3.1415926535...

$$\pi = \frac{C}{d}$$

We use a special squiggly symbol π for this magic number because it's very important and shows up a lot, not just in math, but in building things, science, and even nature! It's like a secret code that helps us understand circles and lots of other cool stuff.

If you would like to learn more about how Isaac Newton (yes that Newton who discovered gravity by observing the fall of an apple from a tree!) discovered a precise way to calculate π , we suggest this [video](#).

So, pi is a special friend that helps us learn about and play with circles in all sorts of fun ways. And that's why it gets its own special symbol!

Write the symbol for Pi in this space.

But Minecraft is Square!?

Minecraft is like playing with a huge set of square blocks. Everything in the game is made of these squares, which is kind of funny because in real life, not everything is square, right?

Imagine you have a bunch of square blocks, and you want to build something round like a soccer ball. It's going to be tough because all your bricks are square! You'd try to put them together in a way that looks round, but up close, you'd still see the edges of the squares.

In Minecraft, when players want to make something that looks curved or round, they must be clever. They use different kinds of blocks, maybe some stairs or flat pieces, and arrange them so they sort of look like curves from a distance. It's like making a round picture out of lots of little squares.

And here's a cool math idea: if we use tinier squares, the edges start to look less blocky and smoother, like a real curve. This trick is called "**approximation**," where you use lots of little steps to get closer and closer to something you want.

Even though Minecraft is all squares and straight lines, players use their imagination to build things that look round, which is a fun challenge. It's like making a mini world out of blocks that's kind of like the real world but made of squares.

When we mix Minecraft with numbers like Pi, we can make cool math patterns and shapes, and even learn about how computer games are made. So, playing Minecraft isn't just fun; it's also a neat way to learn about math and computers!

End of Section Quiz

What is Pi used for in mathematics?

- A) To count how many video games you have
- B) To understand the size and shape of round things like circles
- C) To help us understand all those round and curvy shapes we see
- D) To solve puzzles in English class

Why is Pi considered an "irrational number"?

- A) Because it can be easily written as a fraction like $1/2$
- B) Because it stops after a few decimal places
- C) Because it can only be used in Minecraft
- D) Because its decimal goes on forever without repeating

How do players in Minecraft create something that looks round or curved?

- A) By only using square blocks without any arrangement
- B) By arranging blocks creatively to give the illusion of curves
- C) By changing the game's code to allow round blocks
- D) By using a special round block that only exists in PiCraft

What does the concept of "approximation" refer to in the context of Minecraft?

- A) Making everything out of square blocks without any curves
- B) The process of guessing without using any math
- C) Using smaller blocks or arrangements to make edges look smoother and more like a curve
- D) Approximating means to avoid using math in Minecraft

What can we learn from mixing Minecraft with numbers like Pi?

- A) That Minecraft can only be played using square blocks
- B) That Pi is not useful in understanding real-world shapes
- C) That Minecraft is only for building square structures
- D) That we can create cool math patterns and learn about the fundamentals of computer graphics

Section 2: Estimating and Calculating the Area of a Circle

Let's play some Minecraft!

This lesson should take approximately 30 minutes.

Equipment Needed

- Minecraft Education installed on a computer.
- Calculator (or use the computer's built-in calculator).

Introduction

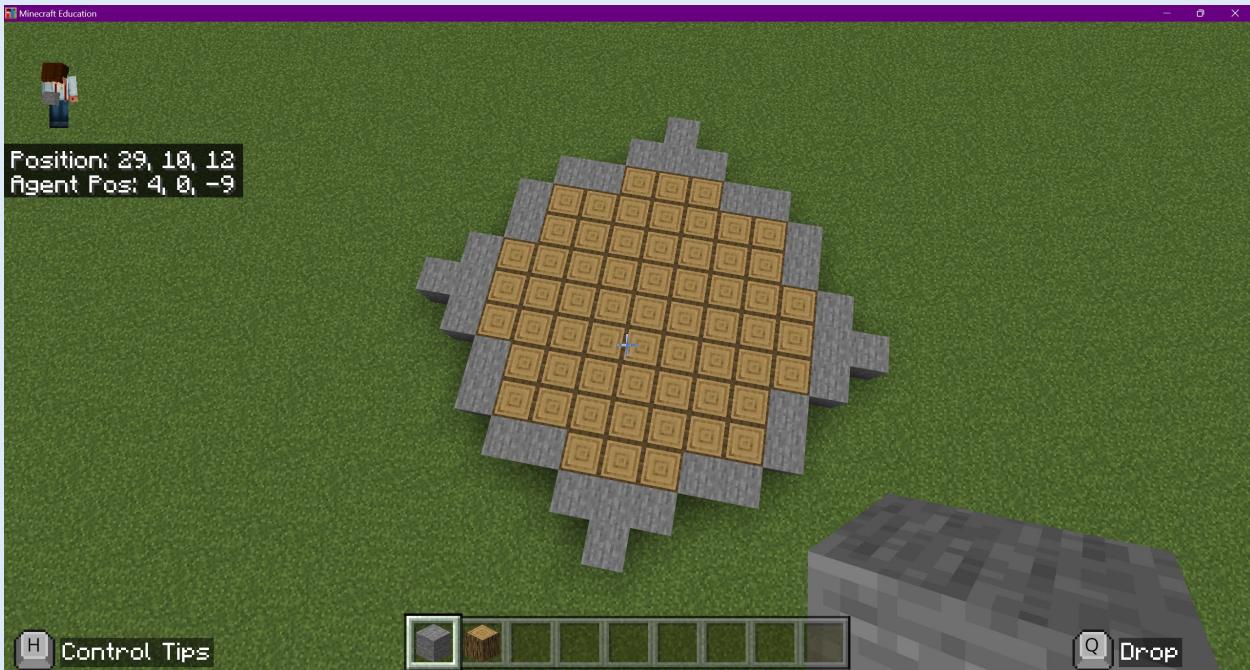
In this lesson, we will explore how to estimate and calculate the area of a circle in Minecraft. This will help us understand the concepts of approximation and the practical use of Pi (π) in geometry.

Count the Blocks

Using Minecraft and any world you like, create a **circle** outline using any materials. Your circle should look like this. This is the '**circumference**' of the circle and I have used 32 blocks to create it.



Using a different block, fill your circle. I used Oak Blocks to fill my stone circle. I used 61 blocks to fill my circle.



How many blocks in total have I used to create my circle?

Write your answer here.

Calculate the Area

Resources (or blocks) in Minecraft are super important. We need to use them carefully in survival mode, and so knowing how many blocks we might need for a structure is helpful. However, counting all the blocks is time-consuming, so is there a quicker and easier way?

Thankfully, Pi can make our lives much easier! Here's a neat formula you can use.

$$A = \pi r^2$$

A is the Area of the circle, or the number of total blocks that make up my circle.

π is the special number we can use with circle calculations.

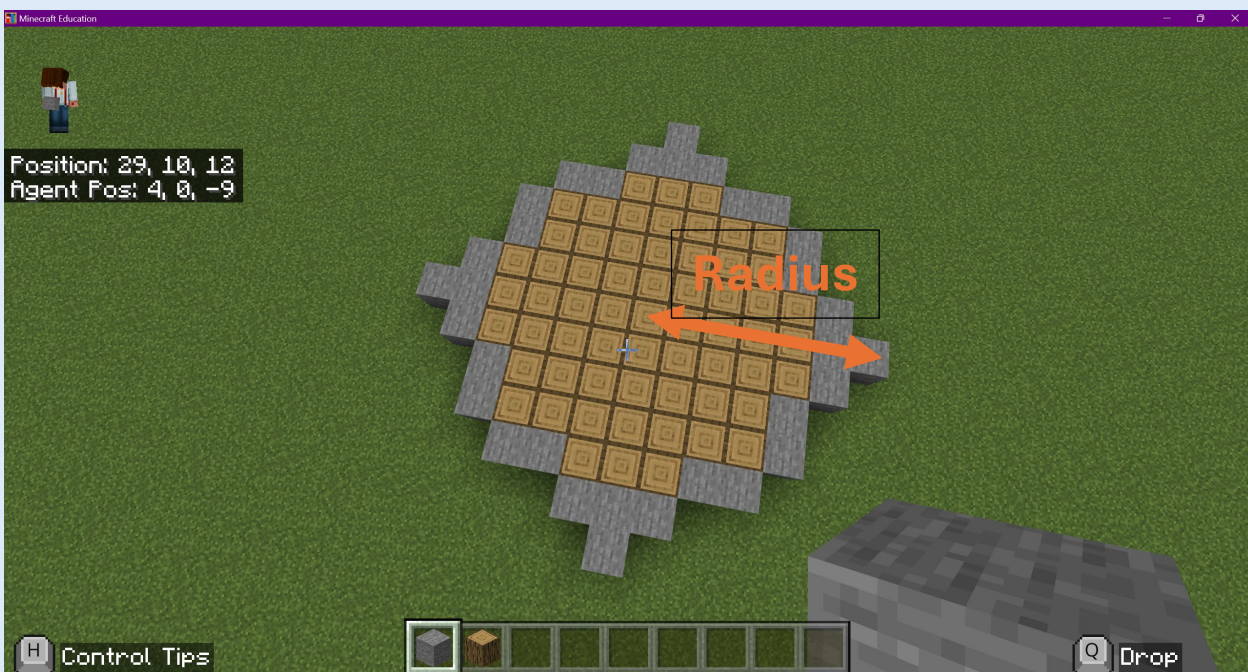
r^2 is the *radius* or distance between the center and the outside of the circle in blocks. The small number 2 means that we *square* the radius or multiply it by itself.

If you would like to learn how this formula is discovered, we suggest this video. You will find the [video](#) visually explains an amazing connection between the formula and the fundamentals of calculus.

The formula for the surface area of a sphere is:

$$\text{Surface Area} = 4 \times \pi \times r^2$$

This is like the area of a circle. You can find out why this is so in this [video](#).



My circle has a Radius of **5 ½ blocks** (We need to go from the absolute center, so that is half a block). So, we can use this measure to calculate the number of blocks used to make my circle.

$$A = \pi r^2$$

$$A = 3.14 \times 5.5^2$$

$$A = 3.14 \times (5.5 \times 5.5)$$

$$A = 3.14 \times 30.25$$

$$A = 94.9$$

That's almost the same answer and quicker than counting all those blocks!

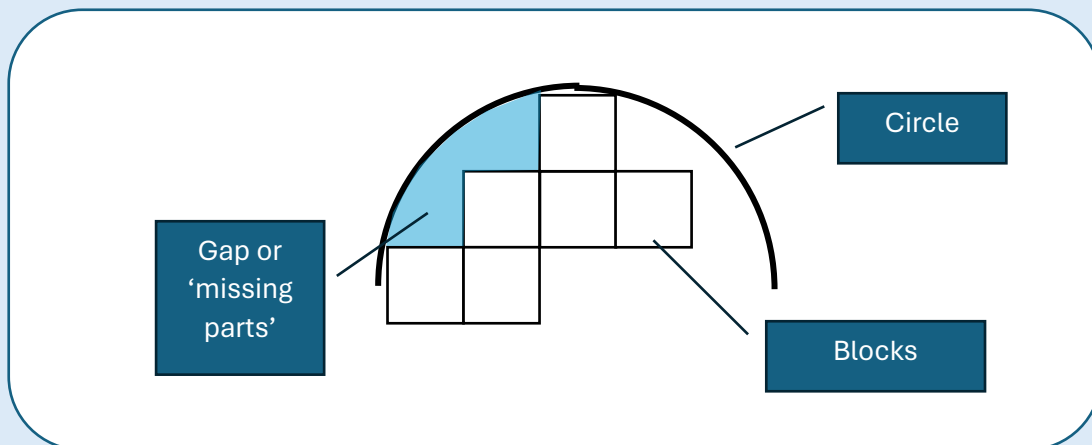
Why is the Answer Different to Counting Minecraft Blocks?

The number of blocks in our circle is 93 blocks. This is less than the formula, which is 94.9 or 95. But, why?

The blocks **represent** a circle and are laid within the circle boundary or **circumference** of the circle. This means that there are small gaps between the blocks' corners and the circle boundary.

If we add up all the missing parts between the blocks and the circle boundary, we make up the difference from 93 to 94.9.

In this sense, Minecraft **approximates** the real circle. Just in the same way as Minecraft could approximate everything real!



Bonus Video

An early form of **geometry** was invented in Egypt out of the need to survey and calculate the area flooded by Nile River. If you are interested in learning more about this, we suggest this [video](#).

Minecraft Circle Building

Now it is your turn. Think about a circle you would like to build. Build the outline of the circle using one type of block, then fill it with another type of block. Make your circle as accurate as possible, reflecting the one shown above.

Use the formula to calculate how many blocks you used.

$$A = \pi r^2$$

Show your working here.

Then, count the blocks.

Was there much difference between your formula and the number of blocks you used?

Write your answer here.

Why was there a difference between the number of blocks and the calculation?

Write your answer here.

End of Section 2 Challenge

Instructions:

Imagine you are going to build the Roman Colosseum in Minecraft. You'll want to read about what a colosseum is by going to [Colosseum - Wikipedia](#)

You'll want to work out how many blocks you might need to build the walls. How could we use PI to help us calculate the number of blocks in the walls?

Write your answer here.

Section 3: The Circumference

This lesson will take about 30 minutes to complete.

Equipment you'll need:

- A copy of Minecraft Education, running on a computer.
- A calculator, or you can use your computer's calculator.

Recap

What is Pi (π)?

Use the space below to explain what Pi is.

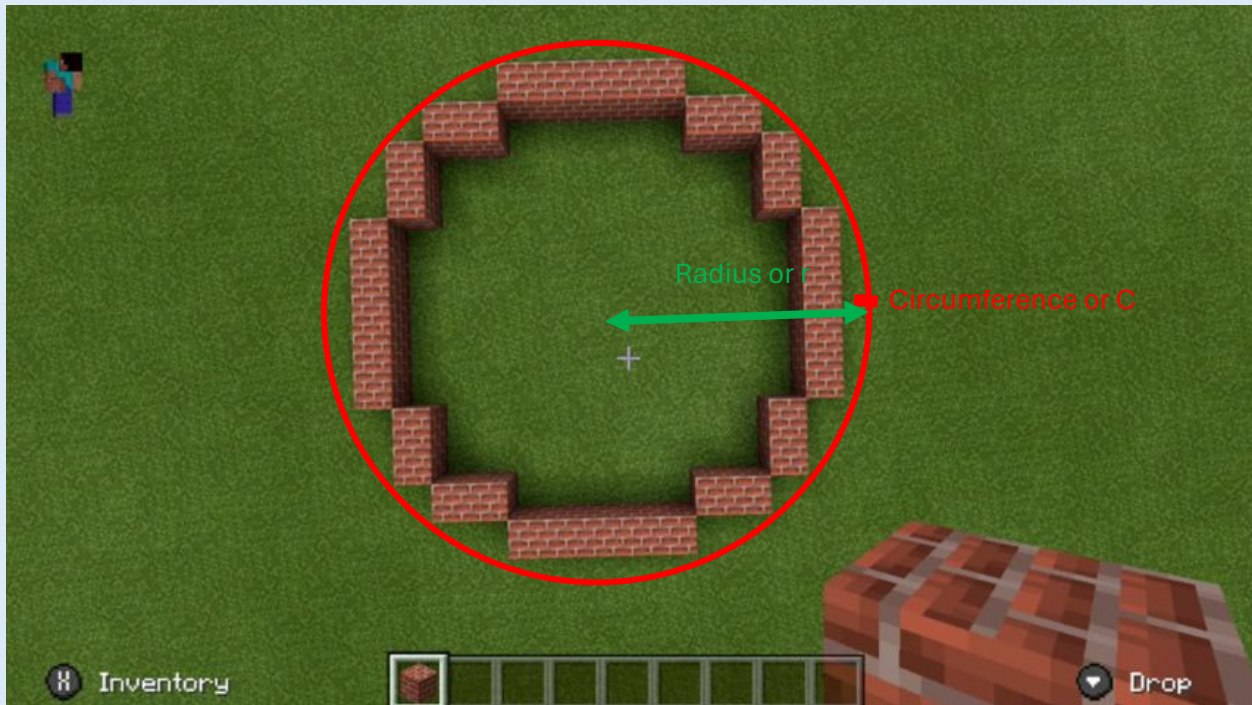
Write your answer in this space.

Why is Pi Important in Mathematics?

Write your answer in this space.

Let's Calculate an Arc

First, remember that a circle is round, and the distance around it is called the circumference. We use a special number called Pi (π), which is about 3.14, to help find the circumference.

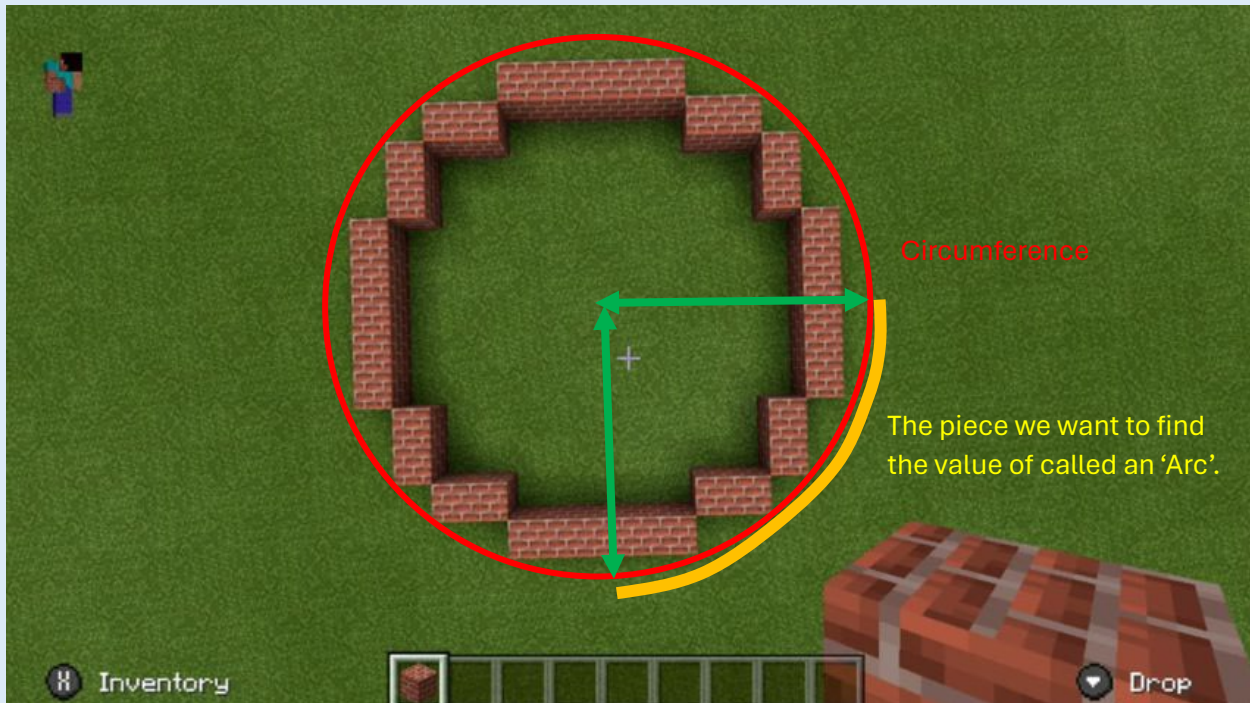


The formula to find the whole way around a circle (the circumference) is.

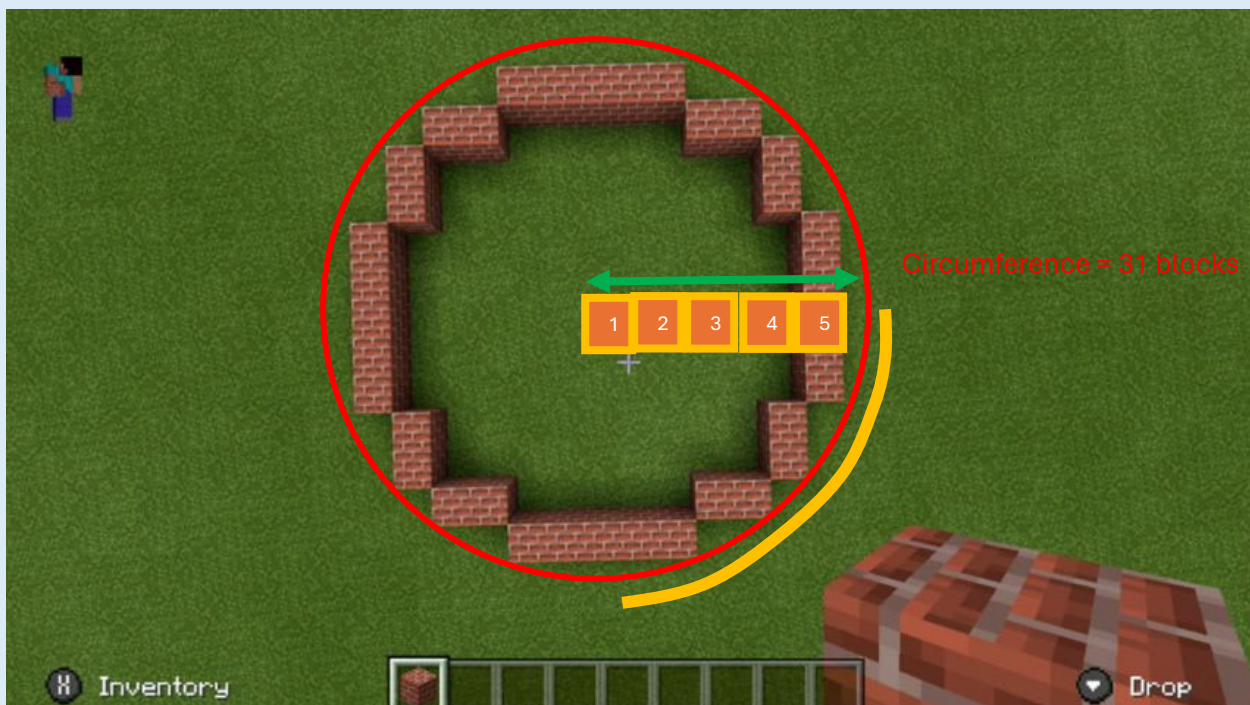
$$C = 2\pi r$$

where C is the circumference (the whole way around the circle) and r is the radius (the radius is the distance from the center of the circle to the edge) and π is the special number 3.14.

Imagine a circle like a pizza. If you cut the pizza into four equal pieces, each piece is a quarter-circle. We want to find out the length of the curved part (the crust) of one of those pieces. This length of crust is called an Arc.



First, use the circumference formula with your radius (in blocks). For example, if your radius is 5 blocks (shown below), the circumference formula is $C=2 \times 3.14 \times 5$ blocks.

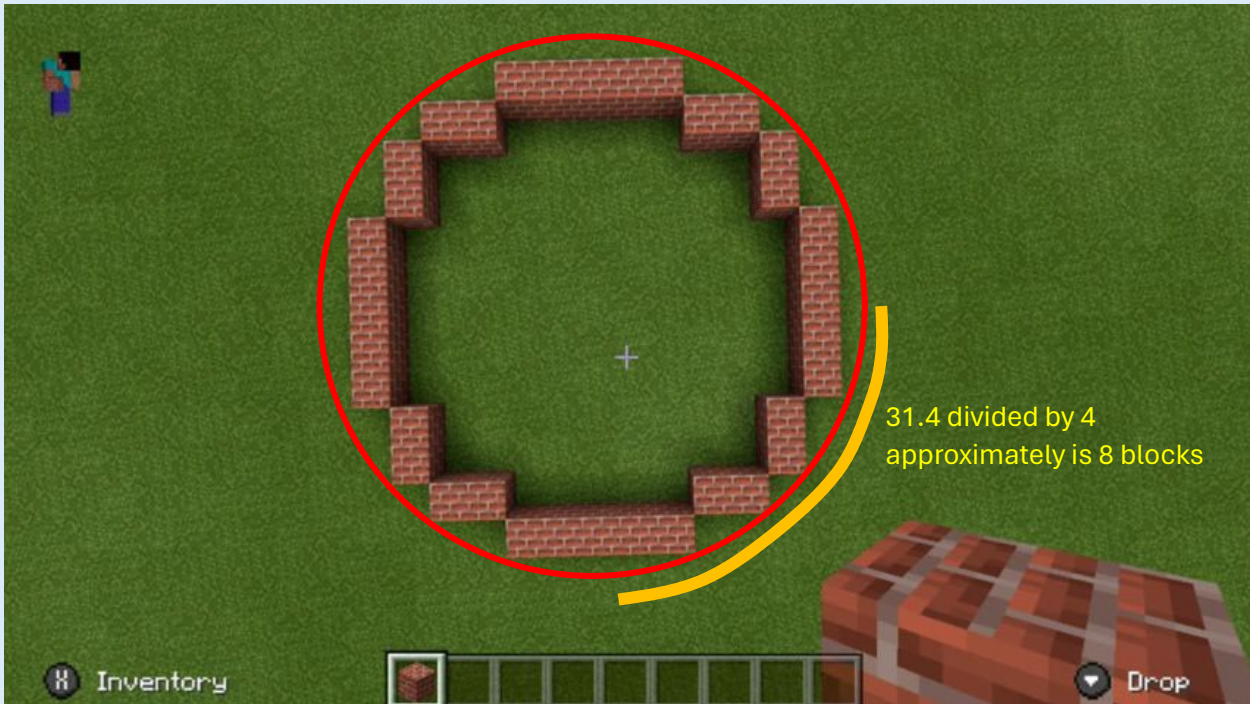


The full circumference would be approximately $2 \times 3.14 \times 5 = 31.4$ blocks.

A quarter-circle is one-fourth of this, so divide the circumference by 4:

$$\text{Arc} = \frac{31.4}{4} = 7.85 \text{ Blocks}$$

Since we can't have a fraction of a block, round this number to the nearest whole block. In this case, it would be 8 blocks.



Calculating a Circumference

Now it is your turn!

If I had a circle that had a Radius of 6 blocks, how many blocks are there in the:

a) Circumference?

b) A $\frac{1}{4}$ arc?

Great! You've learned to calculate an arc in Minecraft blocks.

Why might this skill be useful in Minecraft?

Write your response here.

Minecraft Build Time: Coding a Circle in Minecraft Education

Let's try this with some code!

We can more easily create a circle with computer code.

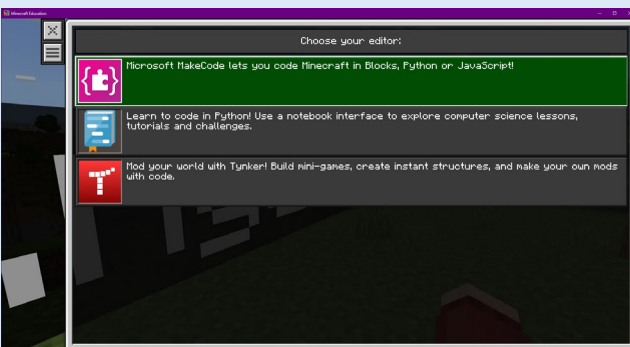
This exercise requires Minecraft Education. For more information about Minecraft Education go to https://aka.ms/piecraft_link1

Building circles is hard in Minecraft because Minecraft is made from squares! So, we can use **code** to make it easier to create the circle. Follow the following instructions to build a circle in your Minecraft world.

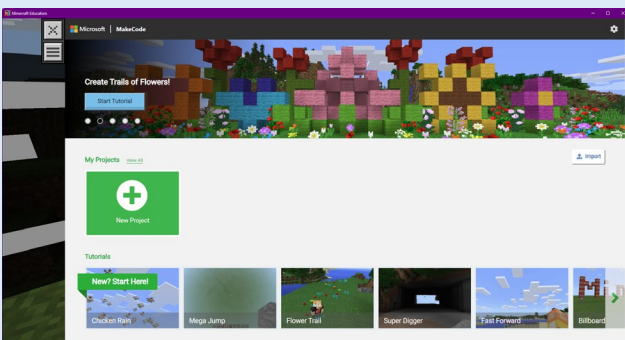
1. Open a Minecraft Education World.



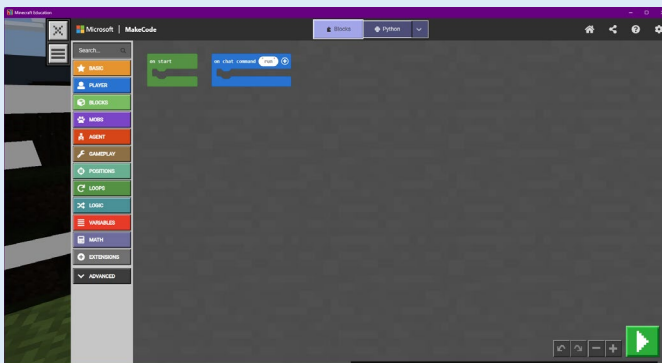
2. Press C on your keyboard to open CodeConnection and Select MakeCode



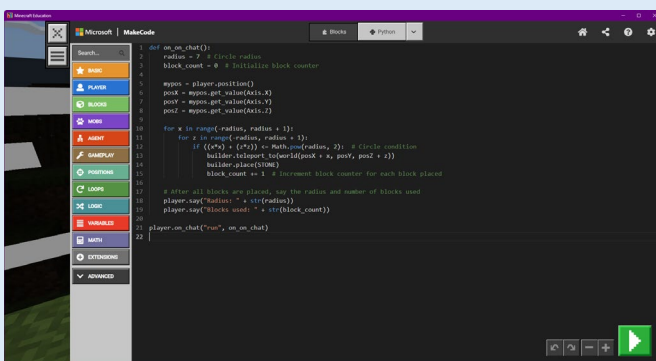
3. Press **New Project** and create a file called 'Circle'.



4. Select **Python** at the top of the MakeCode screen.



- Copy and past the code, at the end of these instructions, into the code editor, replacing the code that is there already.



- Press the green **Run** button in the bottom right corner. Then press **ENTER**.



- Type **run** in the chat box and press **ENTER**.



8. Your circle should build in your Minecraft world.



Code for the Circle

```
def on_on_chat():  
    radius = 7 # Circle radius - you can change this number to make a bigger circle.  
    block_count = 0  
  
    mypos = player.position()  
    posX = mypos.get_value(Axis.X)  
    posY = mypos.get_value(Axis.Y)  
    posZ = mypos.get_value(Axis.Z)  
  
    for x in range(-radius, radius + 1):  
        for z in range(-radius, radius + 1):  
            if ((x*x) + (z*z)) <= Math.pow(radius, 2): # Circle condition  
                builder.teleport_to(world(posX + x, posY, posZ + z))  
                builder.place(STONE)  
                block_count += 1 # Increment block counter for each block placed  
  
    # After all blocks are placed, say the radius and number of blocks used  
    player.say("Radius: " + str(radius))  
    player.say("Blocks used: " + str(block_count))  
  
player.on_chat("run", on_on_chat)
```

Extension Exercise: Coding a Circumference

You might want to only build the **circumference** of a circle in Minecraft Education.



To do this press C, then copy and paste the following code into the Python editor.

Code for Circle Circumference Only

```
def on_on_chat():
    radius = 40 # Circle radius
    tolerance = radius # Increase this value to make the outline
thicker
    block_count = 0 # Initialize block counter
    mypos = player.position()
    posX = mypos.get_value(Axis.X)
    posY = mypos.get_value(Axis.Y)
    posZ = mypos.get_value(Axis.Z)
    for x in range(-radius, radius + 1):
        for z in range(-radius, radius + 1):
            # Calculate the distance from the center of the circle to
the current point
            distance = (x*x) + (z*z)
            # Check if the point is within the tolerance for the
perimeter of the circle
            if radius*radius - tolerance < distance <= radius*radius +
tolerance:
                builder.teleport_to(world(posX + x, posY, posZ + z))
                builder.place(STONE)
                block_count += 1 # Increment block counter for each
block placed
    player.say("Radius: " + str(radius))
    player.say("Blocks used: " + str(block_count))
player.on_chat("run", on_on_chat)
```

Run your code by pressing the Green **Run** button and then pressing ENTER and typing **run** in the chat, like the previous exercise.

Section 4 – Space Rockets and Pi

Ever thought about the path that a rocket follows as it goes into space? Here is an example of practical application of pi: you can use Pi to create a rocket trajectory by slightly modifying our code from earlier!

Let's review circles and how the magical number Pi (π) fits into all of this, especially in the context of our rocket's journey into space.

What's a Circle?

Remember that the outer edge that goes all the way around is like the circle's boundary, which we call the circumference.

Now, if you could use a string to go straight from one side of the circle to the other, passing through the center, that's the diameter of the circle. And if you just go from the center to the edge, that's the radius.

In our rocket code, we talked about a "radius" of 150, which means if you were standing at the center of our circle, you'd have to walk 150 steps to reach the edge!

Why Pi Matters in Our Rocket's Journey

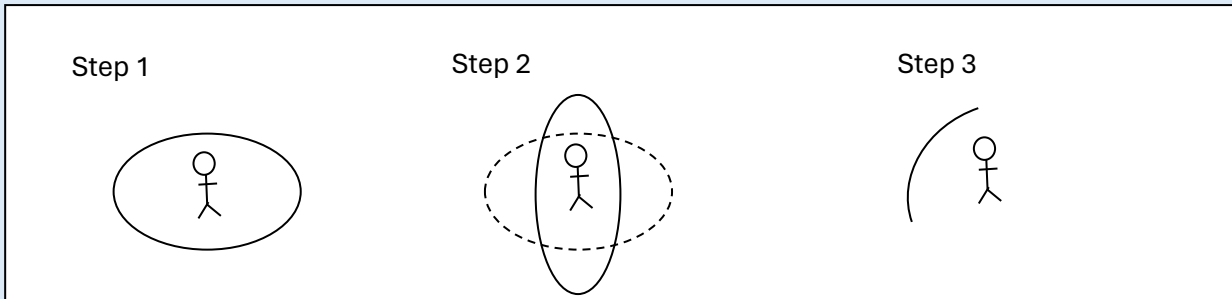
Pi is important because it helps us calculate our rocket's journey.

In section 3, we used Pi to calculate the number of blocks in an Arc. This can be used to calculate the number of blocks that will be used to represent the trajectory (or path) of a rocket. The only difference is that instead of our arc being flat, it is now upright or vertical into space.

When scientists and engineers send real rockets into space, they must be precise, and understanding the trajectories or paths. Pi can help calculate the rocket trajectory, in the same way as we are now going to use it to calculate the number of blocks in our Minecraft rocket launch.

Flat circle to an arc that heads to space!

First, need to change the code we used in Section 3, so that our rocket goes to space.



Imagine we're all standing in a large flat circle at the center (step 1). This circle is on the same level, and we can see the edge or circumference all around us.

Now, we're going to “**transform**” this flat circle into a vertical arc. To do this, we rotate the circle while center point remains anchored (step 2). As the edge lifts, our flat circle begins to curve upwards over our heads.

In this new formation, the circle is above us, rather than around us. We then reduce this to just a part of the circle, to create a **vertical arc**.



atmosphere, and reach the stars.

Code for Rocket Launch

We're going to use code to create our **vertical arc** and simulate the launch our very own rocket into the vastness of space, right from our computers.

Imagine your computer is a powerful space center, and with just a few lines of code, you can command a rocket to soar into the skies, curve gracefully through the

Bonus Point: If you would like to learn why a rocket trajectory is not straight up, we suggest you watch this [video](#).

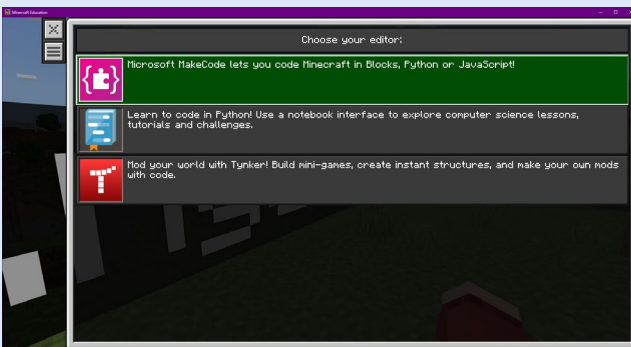
Putting the code into Minecraft

This exercise requires Minecraft Education. For more information about Minecraft Education go to <https://education.minecraft.net/>

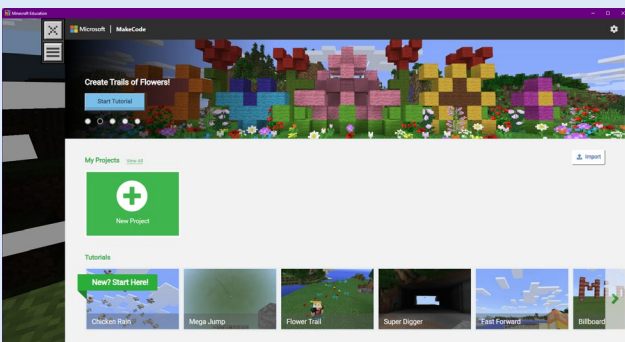
1. Open a Minecraft Education World.



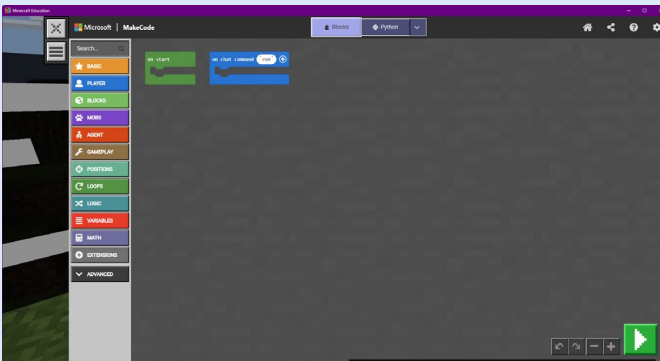
2. Press C on your keyboard to open CodeConnection and Select MakeCode



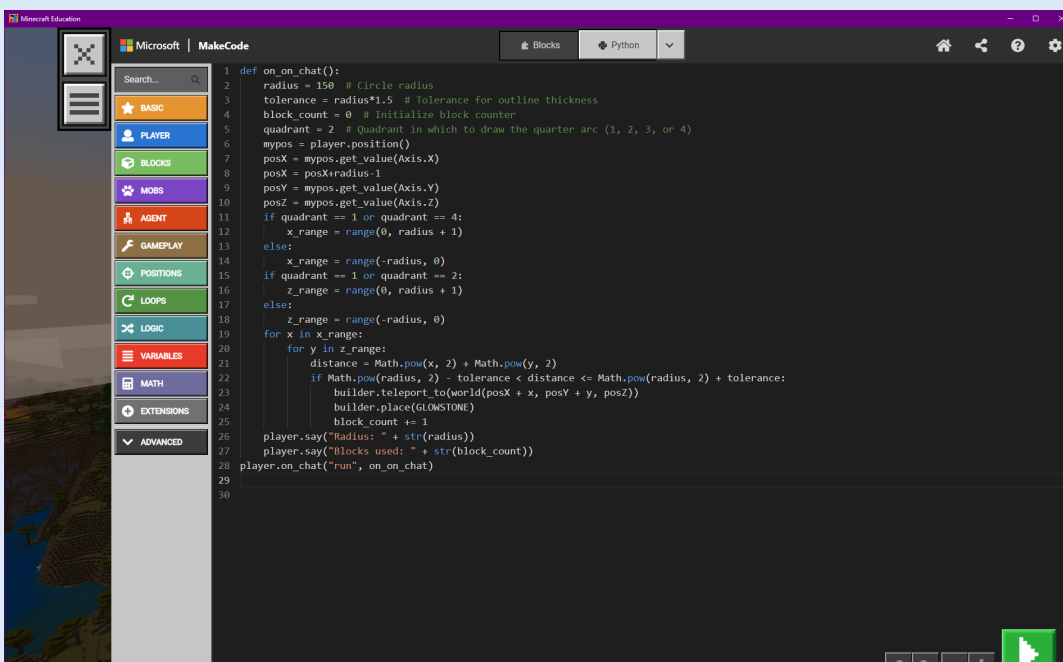
3. Press **New Project** and create a file called 'Rocket'.



4. Select **Python** at the top of the MakeCode screen.



5. Copy and paste the code, at the end of these instructions, into the code editor, replacing the code that is there already.



6. Press the green **Run** button in the bottom right corner. Then press **ENTER**.



7. Type **run** in the chat box and press **ENTER**.



8. Your circle should build in your Rocket Launch Arc.



Code for Space Rocket Trajectory

```
def on_on_chat():
    radius = 150 # Circle radius
    tolerance = radius*1.5 # Tolerance for outline thickness
    block_count = 0 # Initialize block counter
    quadrant = 2 # Quadrant in which to draw the quarter arc (1, 2, 3, or 4)
    mypos = player.position()
    posX = mypos.get_value(Axis.X)
    posX = posX+radius-1
    posY = mypos.get_value(Axis.Y)
    posZ = mypos.get_value(Axis.Z)
    if quadrant == 1 or quadrant == 4:
        x_range = range(0, radius + 1)
    else:
        x_range = range(-radius, 0)
    if quadrant == 1 or quadrant == 2:
        z_range = range(0, radius + 1)
    else:
        z_range = range(-radius, 0)
    for x in x_range:
        for y in z_range:
            distance = Math.pow(x, 2) + Math.pow(y, 2)
            if Math.pow(radius, 2) - tolerance < distance <= Math.pow(radius,
2) + tolerance:
                builder.teleport_to(world(posX + x, posY + y, posZ))
                builder.place(GLOWSTONE)
                block_count += 1
    player.say("Radius: " + str(radius))
    player.say("Blocks used: " + str(block_count))
player.on_chat("run", on_on_chat)
```

Understanding the Code

Let's break down this code into simpler parts to understand what it's doing.

Starting the Function: The code begins with a function called `on_on_chat()`. This is a special kind of function that might run when a player types a certain command in a chat in a game, like Minecraft.

Setting Up Variables:

- `radius = 150` means we're talking about a big circle that's 150 blocks wide all around.
- `tolerance = radius*1.5` is a bit like saying, "We can be a bit flexible (or tolerant) about where the edge of our circle is, making it a bit thicker."
- `block_count = 0` is like starting a counter at zero because we're going to count something soon.
- `quadrant = 2` is like saying, "Imagine if we cut a big pizza into 4 pieces, we're going to work on the second piece."

Finding Out Where We Are: The next few lines are about figuring out exactly where the player is standing in the game world, getting the X, Y, and Z coordinates (which are like the game's way of saying "left and right," "up and down," and "forward and backward").

Deciding Where to Draw: Depending on which piece (or **quadrant**) of the circle we're working on, we choose different ranges to draw in. This part just sets up the limits for where we'll draw our circle part.

Drawing the Circle Part: Now, we start the real work! We go through our decided ranges and for each spot, we calculate a special number (distance) that tells us how far we are from the center of our circle.

- If this number is just right (not too big, not too small, but within our 'tolerance'), we say, "This is the edge of our circle!"
- At those edge spots, we move our builder there and place a glowing block (like a shiny stone in the game).
- We also count each glowing block we place with `block_count += 1`.

Telling the Player: After all that, we tell the player two things: how big the circle was supposed to be, and how many glowing blocks we used to draw the edge of the circle part.

Listening for the Command: The very last line, `player.on_chat("run", on_on_chat)`, means "When the player types 'run' in the chat, do all the stuff we just talked about."

So, in simple words, this code is like a magic spell for drawing a glowing edge of part of a big circle part on the ground in a game, a bit like a rocket trajectory!

Using Pi with our Arc

Now that we understand how circles and Pi work, let's dive into how we can use Pi to calculate the number of blocks we'll use in our arc, part of the rocket's trajectory.

The Role of Pi in Arc Calculations

An arc is essentially a part of the circumference of a circle. Since we know the circumference of a circle is $C=2\pi r$, we can use a fraction of this formula to estimate the length of our arc. For a full circle, the arc length is the circumference, but for a quarter arc (like in our rocket trajectory), it's approximately **¼ of the total circumference**.

Estimating Blocks in the Arc

To estimate the number of blocks in our arc, we need to calculate the length of the arc and then approximate how many blocks would fit into that length. Given our radius of 150 blocks, the total circumference of our circle would be $2\pi \times 150$.

For a quarter arc, this would be:

$$\text{Quarter Arc Blocks} = \frac{1}{4} \times 2\pi \times 150$$

Let's do the math to find out how many blocks this quarter arc would approximately contain.

Calculation

First, we'll calculate the total circumference using Pi ($\pi \approx 3.14$) and our radius (150 blocks). Then, we'll find the quarter arc length by dividing the total circumference by 4. Finally, we'll round this number to get an estimate ("approximation") of the number of blocks, since we can't have a fraction of a block in Minecraft.

Let's perform these calculations.

$$\text{Quarter Arc Blocks} = \frac{1}{4} \times 2\pi \times 150$$

$$\text{Quarter Arc Blocks} = \frac{1}{4} \times 2 \times 3.14 \times 150$$

$$\text{Quarter Arc Blocks} = 236$$

The calculation shows that our quarter arc, which is part of the rocket's trajectory, would approximately contain 236 blocks.

But the thickness of our circumference in the code is 1.5, because we used `tolerance = radius*1.5`.

So, we should multiply the blocks by 1.5 to get the total number of blocks we would use.

$$\text{Quarter Arc Blocks} = 236 \times 1.5$$

$$\text{Quarter Arc Blocks} = 354$$

This estimate helps us understand how Pi plays a crucial role in determining the structure and path of our rocket's journey into space.

The code shows us how many blocks we used, and this is 356 for a radius of 150. So, the code gives a good approximation of the arc. This is because Minecraft blocks are square and not perfectly suited for creating smooth curves, more blocks may be needed to approximate a curved shape, leading to slight discrepancy in the number of blocks used versus the theoretical number of blocks calculated.

If you would like to learn more, check out this video [“Easy Orbital Mechanics – Getting to the Moon”](#)

Answers

Introduction: Quiz 1

C, D, B, C, D

Estimating and Calculating the Area of a Circle

Question 1: $Answer = 33 + 61 = 89$ Blocks

End of Section 2 Challenge

Model Answer: The Colosseum is a circle structure, and while Minecraft primarily uses square blocks, you can approximate the shape by creating a circle or ellipse for the outer wall. To calculate the number of blocks needed for the walls, you can use the formula for the circumference of a circle, which is $2\pi r$, where r is the radius. We'll need to decide on the scale of your Colosseum in Minecraft, then determine the radius (or major and minor axes for an ellipse) in blocks. Multiply this by π (approximately 3.14) to get the circumference, which will give you an estimate of the number of blocks needed for one layer of the wall. Multiply this by the height of the wall to get the total number of blocks.

Section 3: What is Pi?

Model Answer: Pi (π) is a mathematical constant that represents the ratio of a circle's circumference (the distance around the circle) to its diameter (the distance across the circle through its center). Pi is an irrational number, meaning it cannot be expressed exactly as a simple fraction and its decimal representation goes on indefinitely without repeating. The value of Pi is approximately 3.14159, but it is often approximated in mathematics as 3.14 for simplicity in calculations. Pi is a fundamental element in geometry, especially for calculations involving circles and circular shapes. It is used in formulas for computing the circumference and area of a circle, where the circumference is calculated as

Section 3: Why is Pi Important in Mathematics?

Model Answer: Pi is like a magic key in geometry because it helps us understand circles and shapes with curves. Imagine you have a perfectly round pizza, and you want to know how big it is around, or how much crust there is; Pi helps you figure that out! It's also super important for building things like wheels and arches, making sure they're just the right size. So, Pi is important because it helps us measure and understand round things in our world.

Section 3 - Calculating a Circumference

Answers:

a)

$$C = 2 \times 3.14 \times 6 = 37.68 \text{ Blocks}$$

b)

$$\text{Arc} = 37.68 \div 4$$

$$\text{Arc} = 9.42$$

$$\text{Arc} = 9 \text{ Blocks}$$

Section 3 – Why might this skill be useful in Minecraft?

Model Answer: Learning to calculate arc lengths in Minecraft is helpful for several reasons. It makes it easier to build curved structures like arches or round towers, which can be tough because Minecraft blocks are square. Knowing how many blocks to use before starting helps with planning and makes sure we have enough resources. This knowledge also lets builders make their constructions more complex and cooler, like adding domes or circular arenas.

Lesson Plans for Educators

This worksheet has been broken down into three lessons of 45 minutes.

Overall Objective:

Students will explore mathematical concepts through Minecraft, focusing on the significance of Pi (π), understanding irrational numbers, and applying these concepts in building circular structures within the game. This lesson plan aims to make math engaging by integrating it with Minecraft, encouraging students to apply mathematical thinking in a creative and interactive environment.

Session 1: Discovering Pi and Its Mysteries (45 minutes)

Materials Needed:

- Computers with Minecraft Bedrock, Minecraft Java or Minecraft Education installed.
- Projector or smartboard for demonstration
- Printed worksheets for end-of-section quiz

Outline:

Introduction (10 minutes):

Begin with a discussion on how math is not just about formulas but also about solving puzzles and understanding the world around us.

Introduce Pi (π) as a fundamental concept in math that helps us understand circular shapes and their properties.

Interactive Storytelling (10 minutes):

Use storytelling to explain the concept of Pi, relating it to everyday circular objects and its significance in various fields.

Highlight the historical aspect of Pi and its role in ancient and modern sciences.

Minecraft Exploration (20 minutes):

Students will log into Minecraft and start exploring the creation of circular structures using square blocks.

The instructor will demonstrate building a simple circular structure and discuss the challenges of approximating curves with squares.

Quiz and Discussion (5 minutes):

Conclude the session with a short quiz based on the introduction to Pi and its properties.

Discuss the answers as a class and clarify any misconceptions.

Session 2: Building with Pi in Minecraft (45 minutes)

Materials Needed:

- Computers with Minecraft Bedrock, Minecraft Java or Minecraft Education installed.
- Calculators (or use the computer's built-in calculator)
- Worksheets for recording calculations and reflections

Outline:

Recap and Introduction to Practical Activity (5 minutes):

Quickly recap the concept of Pi and its significance.

Introduce the day's activity: estimating and calculating the area of a circle in Minecraft.

Minecraft Activity Part 1: Estimation (20 minutes):

Students will create a circle outline in Minecraft and fill it with blocks, estimating the total number of blocks used.

They will record their estimations and compare with their peers.

Mathematical Calculation (10 minutes):

Using the formula $A=\pi r^2$, students will calculate the area of their circle and compare it to their estimation.

Discuss the concept of approximation and how it is used in both math and Minecraft.

Reflection and Sharing (10 minutes):

Students share their findings with the class, discussing any challenges they faced and how they overcame them.

Reflect on the importance of approximation in mathematics and in creating digital worlds.

Session 3: The Circle Challenge - Understanding Circumference and Arcs (45 minutes)

Materials Needed:

- Computers with **Minecraft Education** only
- Calculators
- Worksheets for exercises and reflection

Outline:

Brief Recap and Introduction (5 minutes):

Recap the previous sessions, focusing on Pi and its use in calculating area.

Introduce new concepts: circumference and arc length.

Minecraft Activity: Building and Calculating Circumference (15 minutes):

Students will build a larger circle in Minecraft and calculate its circumference using $C=2\pi r$.

Discuss the concept of circumference as it relates to circular structures in Minecraft.

Arc Exploration in Minecraft (15 minutes):

Introduce the concept of an arc as a part of the circumference.

Students will modify their circles to create an arc and calculate its length, applying their knowledge of Pi and fractions.

Group Discussion and Wrap-Up (10 minutes):

Students present their arcs and explain the mathematical process used to calculate the arc length.

Discuss how these mathematical concepts apply to real-world scenarios and the importance of understanding circular geometry.

Additional Notes for Educators:

Encourage students to work in pairs or small groups to foster collaboration.

Be prepared to assist students with the mathematical concepts, especially if they struggle with the calculations.

Use the Minecraft environment to illustrate mathematical principles, making abstract concepts more tangible.

Adapt the difficulty of the tasks based on the age and skill level of the students, possibly extending the tasks for older or more advanced students.

Consider incorporating a reflection session at the end of the three sessions to discuss what students have learned and how they can apply these concepts outside of Minecraft.

Kahoot! Quiz

There is a Kahoot! Quiz that works alongside this resource and you can use it to test knowledge and understanding about the content of this resource.

[Kahoot Quiz](#)

Access the Kahoot! Quiz using the above link.

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