Learning is complex.
Assessment should be, too.

New York Performance Standards Consortium

Mathematics PBAT

SY 2026 - 2027 Edition

20 PROBLEM SAMPLE

Table of Contents:

Abbreviated Quality & Criteria + Definition of a Non-Routine Problem

Mathematics PBAT Rubric

PBAT Problem Set

Abbreviated Quality & Criteria + Definition of a Non-Routine Problem for a Mathematics PBAT

Introduction

A performance-based assessment task (PBAT) in mathematics presents a non-routine, complex problem that allows multiple problem-solving approaches and serves as a final showcase of students' mathematical thinking. Non-routine problems are “cognitively non-trivial task[s]; [where] the solver does not already know a method [for solving]" (Selden, A., Selden, J., Hauk, S., & Mason, A., 2000, p. 129). Because there are no set formulas or procedures for solving non-routine problems, solvers must apply learned concepts, facts, and strategies in new ways. Solving them requires creativity and originality, allowing each student’s unique thought process to be expressed in their written work. The need for creativity and originality is a primary reason why the non-routine problem is a worthy criterion for graduation.

The Non-Routine Math PBAT Problem guides all the Consortium’s work in mathematics (curricula, facilitation, interim assessments, and professional development). Becoming a student who excels in their PBAT builds over time and requires a consistent pedagogy aligned with it. Designing a math program that encourages independent thinking will enhance students' approach to the PBAT. By providing diverse, low-stakes problem-solving experiences in high school, students will be consistently challenged, fostering independence and self-reflection as problem solvers.

Students' PBAT work must reflect their highest level of understanding. The aim is to foster independence and promote critical thinking—students may experience a range of emotions throughout the process.

The PBAT has two components: the paper and the oral defense. The PBAT paper documents the problem-solving journey, sharing the highs and the lows of their process. In the oral defense, students present their work to a knowledgeable panel that offers encouragement, feedback, and challenges to extend their thinking. The written and oral components are graded separately.

PBAT tasks should align with the five dimensions of the Consortium Math rubric, essential for promoting deep mathematical reasoning. Upcoming sections will examine important aspects of math PBAT, focusing on independent thinking, metacognition, scaffolding, and differentiation.

Independent Mathematical Thinking

An independent thinker recognizes multiple problem-solving approaches, connects different aspects of their mathematical experiences together, and relates conceptual ideas to procedural methods in their PBAT. They demonstrate perseverance, defend their reasoning, and take responsibility for both the process and result in their work.

A teacher's role is to be curious about students' thinking and to encourage them by asking questions, celebrating small wins, building trust, and assessing readiness. The focus is on fostering student thinking rather than providing answers or excessive help.

Revision is a crucial part of writing. Through the revision process, the work must genuinely reflect the student's ideas. Students should identify what needs to change, why, and how to implement those changes, ensuring the process stays true to their original thoughts.

Student Metacognition

Alan Schoenfeld, a prominent expert in mathematical problem solving, emphasizes the need for students to critically analyze their work. Understanding their thought processes and self-regulating during problem-solving are vital for student growth. Student metacognition can be articulated throughout the paper. Students might discuss:

- What approach did they take and why?
- Did they need to rethink their approach? Why? What did they learn about the problem in doing so? How did what they learned inform what they did next?
- How did they become convinced that their thinking about the problem was correct and that their solution made sense?

Scaffolding and Scripting

Varying levels of scaffolding can be important for students, but the aim should always be to meet students where they are at their highest level of mathematical thinking. While scaffolding can support student understanding, it may also restrict their ability to think freely. As facilitators, we should only intervene when necessary. If a student struggles with the mathematics needed for a PBAT task, they should pause and review the content in a different context. It's best if a student recognizes this and pursues the knowledge they need on their own.

Alternatively, scripting guides students through a problem with statements or questions, limiting their focus and independent thought. Students should be given time to think and choose their own problem-solving strategies, even if their reasoning is imperfect or inefficient. *Scripting should not be used during the PBAT. If a teacher thinks scripting is needed for a PBAT, the problem may not be a good match for the student.*

Matching & Student Choice

By understanding our students well as mathematical thinkers, students, and people, teachers can challenge them to reach their highest level of mathematical thinking by matching them with a suitable problem.

Student choice can boost engagement, personal connections, and accountability while fostering critical thinking and original work. If a student is given the opportunity to choose their

own problem, the teacher should curate a subset of 3, at most 4, problems that each match the student well; more options reduce the time a student has to work on their problem, paper, and presentation.

Closing Remarks

The expectations in this document may challenge teachers, but we believe our students can thrive by exploring new ways of thinking mathematically. Evidence shows this can yield powerful results. As we conclude, we pose this guiding question:

- How can I ensure my students have a memorable PBAT experience in math that deepens their thinking?

New York Performance Standards Consortium
Performance Assessment: Mathematics

Student _____

Project Title (e.g. Mathematical Modeling, The Can Project): _____

Project Topic (e.g. Linear programming, Volume -surface area optimization): _____

Circle One: **Written** **Oral**
Circle One: **Teacher** **External Evaluator**

Evaluator (Print name)_____

Overall Holistic Evaluation _____ **Signature** _____ **Date**_____

09/2016

Performance Indicators	Outstanding	Good	Competent	Needs Revision
Problem Solving	Selects appropriate and efficient strategies to solve non-routine problems. Provides in-depth analysis of strategies Executes conceptually sound mathematical procedures accurately.	Selects appropriate and efficient strategies to solve non-routine problems. Provides some analysis of strategies Executes conceptually sound mathematical procedures with minor computational errors.	Selects appropriate, but inefficient, strategies to solve non-routine problems, and executes conceptually sound mathematical procedures with minor computational errors. or Selects appropriate and efficient strategies to solve non-routine problems but executes mathematical procedures with minor conceptual and computational errors.	Selects an inappropriate strategy or Makes major conceptual errors or procedural errors.
Reasoning & Proof	Makes valid conceptual/theoretical argument(s) and mathematically justifies it logically and thoroughly.	Makes valid conceptual/theoretical argument(s) and mathematically justifies it logically.	Makes argument(s) and justifies most mathematical statements accurately.	Makes arguments but does not justify mathematical statements accurately.
Communication	Always uses mathematical language and notations accurately. Always clearly explains mathematical thinking in an organized and detailed way.	Mostly uses mathematical language and notations accurately. Mostly clearly explains mathematical thinking in an organized and detailed way.	Sometimes uses mathematical language and notations accurately. Sometimes clearly explains mathematical thinking in an organized and detailed way.	Limited use of mathematical language and notation in an accurate manner. Rarely clearly explains mathematical thinking in an organized and detailed way.
Connections	Demonstrates an in-depth understanding of the relationships between mathematical concepts, procedures, and/or strategies.	Demonstrates an understanding of the relationships between mathematical concepts, procedures, and/or strategies.	Demonstrates a limited understanding of the relationships between mathematical concepts, procedures, and/or strategies.	Does not demonstrate understanding of the relationships between mathematical concepts, procedures, and/or strategies.
Representation	Creates an accurate and sophisticated mathematical representation(s), inherent to the task, to solve problems or portray solutions.	Creates an accurate mathematical representation(s), inherent to the task, to solve problems or portray solutions.	Creates an accurate mathematical representation(s), inherent to the task, to solve problems or portray solutions, but may be imprecise or contain minor errors.	Does not create an accurate mathematical representation, inherent to the task, to solve problems or portray solutions.

65 Mathematics Problems for PBATS

(1) For Strongest Students

1. Last Artist Standing
2. Sums of Consecutive Counting Numbers (with proof)
3. The Peg Game (SY26-27 Last Year in Problem Set)
4. Triangles and More Triangles
5. Squares and Rectangles on a 10 by 10 grid
6. What is the unit's digit?
7. Making Connections
8. An Array from 1 to 26
9. Multitude of Triangles

(2) For Middle Students

1. Counting with Shapes (Figurate numbers)
2. McNuggets
3. The Game of 27 (SY26-27 Last Year in Problem Set)
4. Zeros
5. I Take, You Get; You Take, I Get

(3) For Students who struggle in math / who have had an interrupted or limited math education

1. New Friends and Triangular Numbers
2. The Race (SY26-27 Last Year in Problem Set)
3. The Spiral Alphabet
4. Trains
5. The Three Problems
6. Growing Dots and Growing Objects (Moved from Group 2 to Group 3)

Section 1:

For the Strongest Students

Top

Last Artist Standing

One thousand Artists stood in a very large circle. Each, starting with the Jennifer Lopez look-alike, wore a sign on his or her back with a numeral from 1 to 1000 in a clockwise sequence. They began counting off. The Jennifer Lopez look-alike said, “One in,” and remained in the circle. The 7”6’ basketball player to her left said, “Two out,” and left the circle. The rap singer next in sequence said, “Three,” and remained in the circle. The United States Senator who was next in sequence said, “Four out,” and left the circle.

So it continued with each person sporting an odd numeral stating the numeral, saying “in,” and remaining in the circle, and with every person wearing an even numeral leaving the circle.

It was easy to visualize who remained in the circle when the count-off again reached the Jennifer Lopez look-alike. Since the person before her said, “One thousand out,” and left the circle, she now said, “One in,” and stayed in the circle. Continuing this sequence, the rap singer said, “Three out,” and left the circle. This process would keep going on and on until only one person was left in the circle.

Which number is the last artist standing?

Top

Sums of Consecutive Counting Numbers

Which counting numbers cannot be written as a sum of consecutive counting numbers? (Note: Consecutive can be two or more consecutive counting numbers.) Prove that your solution is always true.

Top

The Peg Game

Directions:

1. You can move one chip at a time.
2. A chip can only move forward (not backward).
3. A chip can move into an empty square OR jump over a chip of the other color.
4. A chip may not jump over a same-colored chip.

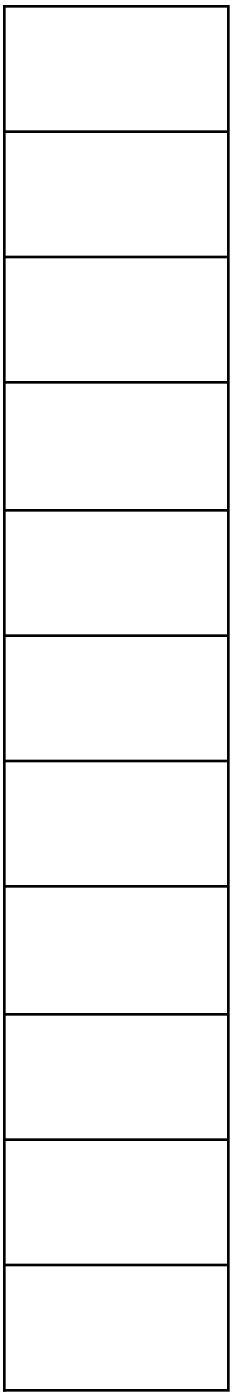
Starting Board:

Y	**Y**	**Y**	**Y**	**Y**		**R**	**R**	**R**	**R**	**R**

Ending Board:

R	**R**	**R**	**R**	**R**		**Y**	**Y**	**Y**	**Y**	**Y**

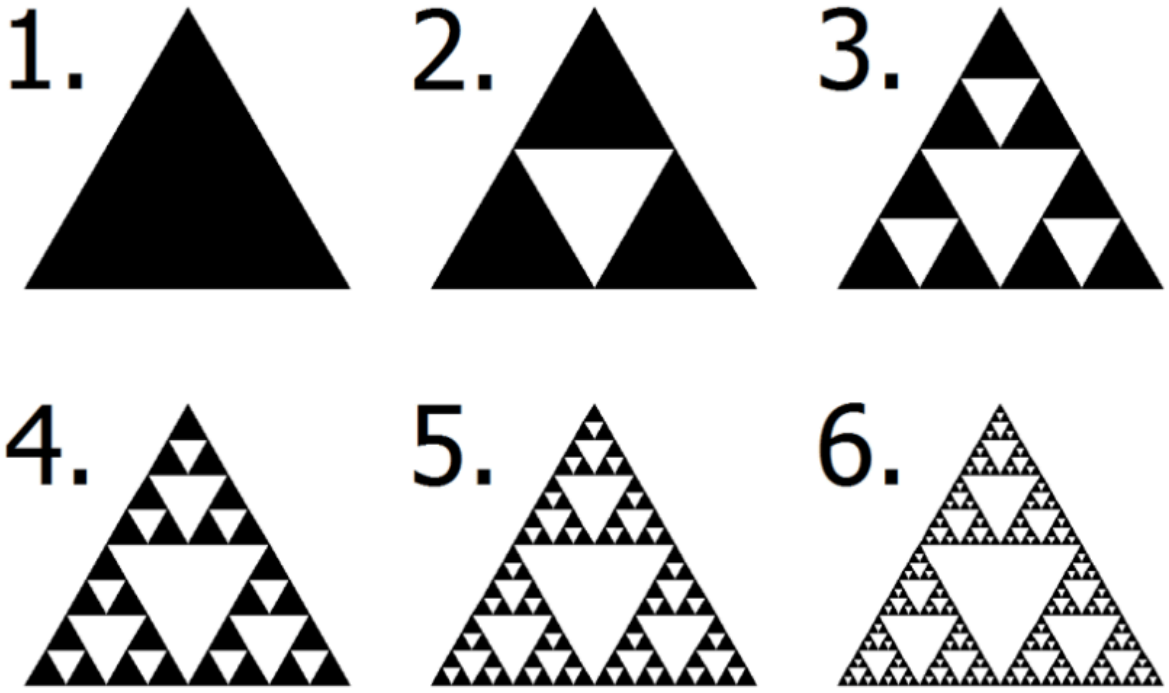
Your Task: Describe mathematically what is happening with as much detail as you can.
Include in your discussion the minimum amount of moves needed to win the game



Top

Triangles and More Triangles

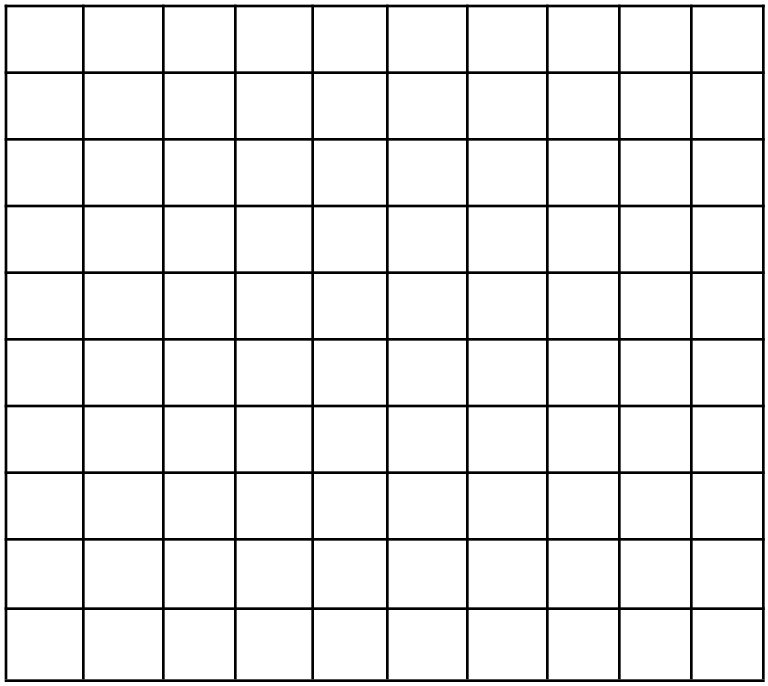
A beautiful pattern is shown below. Your job is to make as much sense out of it as possible. **What questions would you like to answer about this pattern?** Use your greatest mathematical mind to think about this pattern.



Top

Squares and Rectangles on a 10 by 10 Grid

Using the following grid discuss how you would find how many squares are on a 10 by 10 grid. What did you find out? Can you express a way of showing how many squares are on any sized grid?



After you have completed the first question now you should work to find how many rectangles are on a 10 by 10 grid.

Top

What is the unit’s digit?

What is the digit in the unit's place of the sum of $1^1 + 2^2 + 3^3 + 4^4 + \ldots + 99^{99} + 100^{100}$?

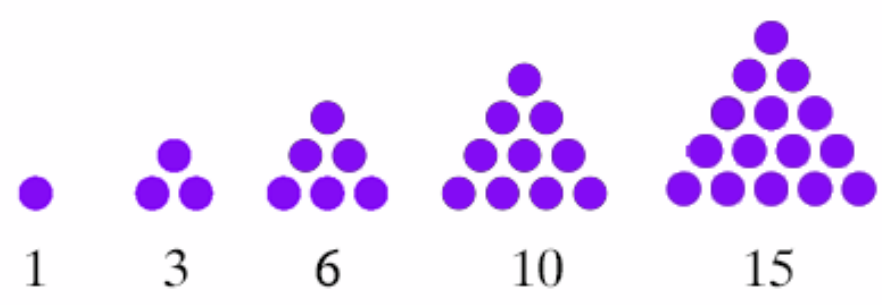
Top

Making Connections

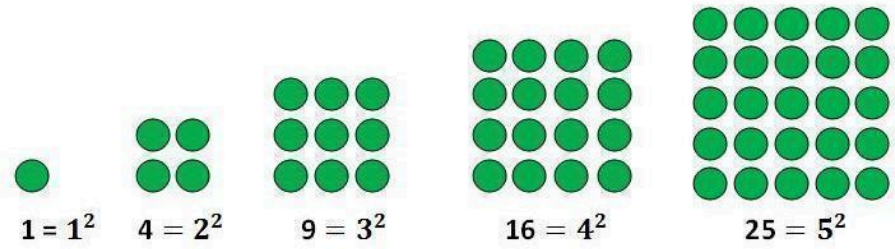
How are triangular numbers, square numbers, hexagonal numbers, rectangular numbers and cubic numbers related?

Mathematical Connections can be powerful, surprising, even beautiful. Some can be very straightforward and other connections can be hidden. What can you find?

Triangular Numbers



Square Numbers

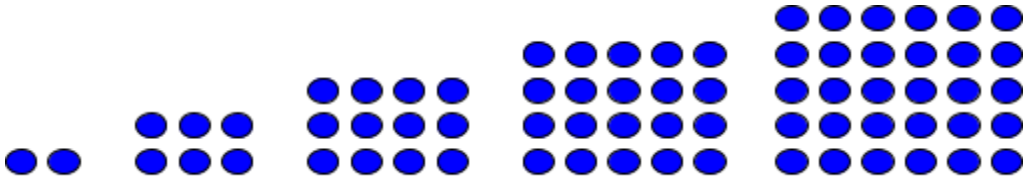


Cubic Numbers



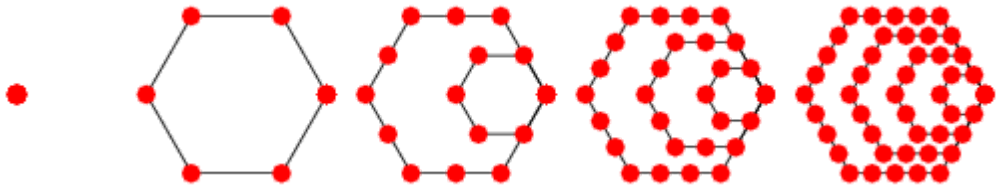
$1 = 1^3$ $8 = 2^3$ $27 = 3^3$ $64 = 4^3$ $125 = 5^3$

Rectangular Numbers



2 6 12 20 30

Hexagonal Numbers



1 6 15 28 45

Top

An Array from 1 to 26

An array consists of the positive integers from 1 to 26. The first row has 1 digit, the second row has 2 digits, the third row has 3 digits, etc. After 26, the digits repeat again from 1 to 26.

The first four rows of an array are

1

2, 3

4, 5, 6

7, 8, 9, 10

What is the first number in the 2020^{th} row?

What is the sum of all the numbers in the 2020^{th} row?

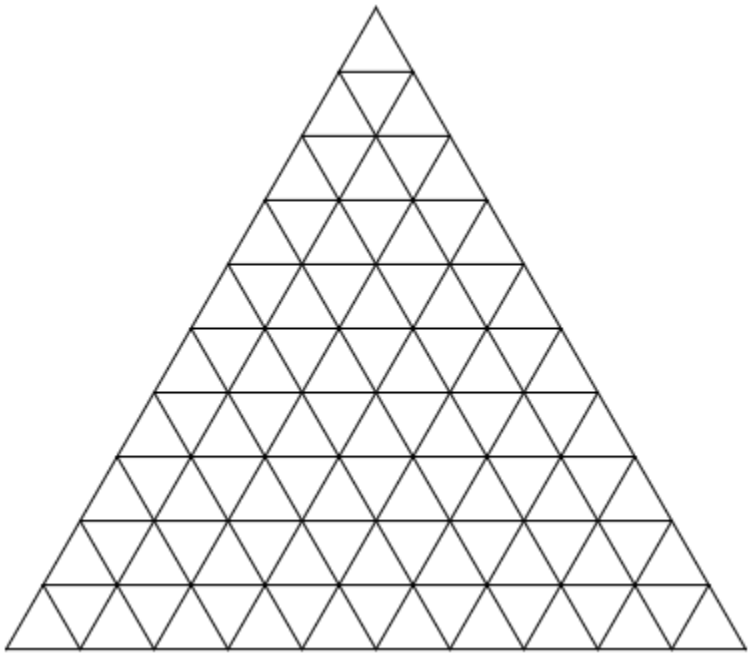
What is the first number in the nth row?

What is the sum of all the numbers in the nth row?

Top

Multitude of Triangles

1. How many triangles are there in the diagram below?



2. What new question(s) would you like to think about? You can talk to your teacher about the new question(s).

Section 2:

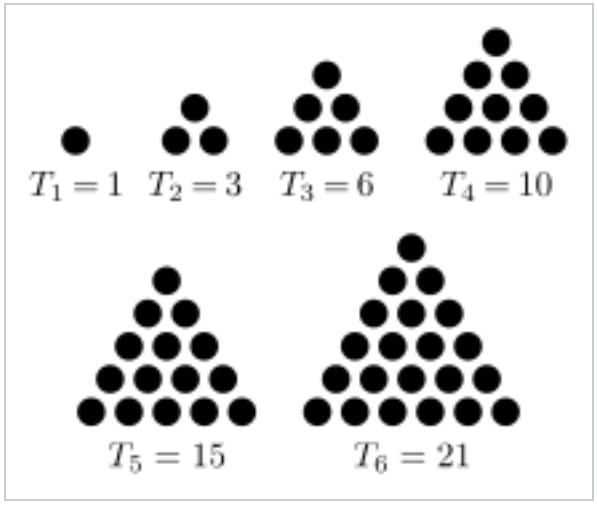
For Middle Students

Top

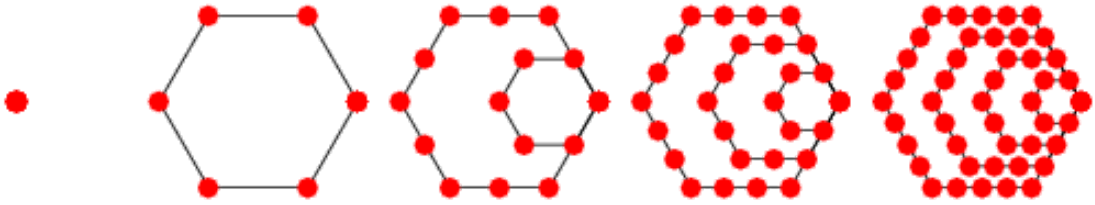
Counting with Shapes

Figurate numbers are **numbers** that can be represented by a regular geometrical arrangement or sequence of evenly spaced points. **Figurate numbers** are most commonly expressed in the form of regular triangles, squares, pentagons, hexagons, etc.

Your task is to explain/describe these two sequences as well you can using your highest level of mathematics.



The first six triangular numbers drawings



The first five hexagonal numbers and drawings

If your thinking hasn't taken you there already, consider these questions:

- What is going on in these two sequences?
- How are these two sequences related?
- What new question would you like to investigate?

Top

McNuggets

You are at a chicken restaurant and you want to buy chicken Mn\cNuggets. At this restaurant you can **only buy** McNuggets in boxes of 8 Mcnuggets, 10 Mcnuggets and 11 Mcnuggets. What is the greatest amount of McNuggets that can't be purchased at this restaurant? Prove that your answer is correct.

Top

The Game of 27

You are going to play a game with the following rules:

- You will be given 27 chips
- There are exactly two players
- The two players will alternate turns
- At each turn, a player removes 1, 2, 3, or 4 chips from the pile.
- The game ends when all the counters have been removed.
- The player who takes the last chip wins the game.

What's the strategy to ensure that a player can win every time he/she plays the game?

Explain the total experience (all the different ideas you tried) you had trying to figure out how to always win the game. Why will your strategy always work?

If you feel you have fully answered the first question then begin to think about this new question: What would be the strategy to always win the game if the player who takes the last chip loses the game?

Top

Zeros

How many digits of zero does **5555!** end with?

Top

I Take, You Get
You Take, I Get

I Take, You Take is a game played by 2 players with the numbers 1-20 laid out on a table.

You and your opponent play using the following rules:

1. Every time you take a number, your opponent takes all its remaining factors.
   Example Turn 1: You take the number 8; your opponent takes 1, 2, and 4.

2. Players take turns taking a number and getting the remaining factors.

3. You may only make a move that leaves your opponent with at least one number.
   Example Turn 2: After taking 8, you cannot take 16 because 8, 4, 2, & 1 were taken. So you must choose a different number that has at least 1 factor remaining on the table.

4. When you cannot take any more numbers, your opponent gets the rest.

5. The winner is the person with the highest sum at the end of the game.

What is the highest score you can get? Show that the score is maximal.

What is the highest score you can get if you play with numbers up to 24? 100?

Top

1001 Coins

There are 1001 pennies lined up on a table.

Starting at one end of the line, I replace every second coin with a nickel. Then, I return to the beginning and replace every third coin with a dime. Finally, I return to the beginning and replace every fourth coin with a quarter.

How much money is now on the table?

Top

Weight Problem

You have a 1kg weight, a 2kg weight, a 4kg weight, an 8kg weight and a 16kg weight to use on a 2-pan balance.



- Can you weigh something that has a mass of 15kg? How?
- Which masses can you weigh with these tools?
- Which masses can you NOT weigh with these tools?

Change the original weights, but keep a similar pattern.

What happens?

Top

Decimal Expansion

Decimal expansion can be interesting and wild.

Here are a set of questions I saw written:

1. Given 1/n is a terminating decimal, what must be true about n?

2. Given a terminating decimal 1/*n*, explain how you could determine the length of the decimal without carrying out the long division. (i.e., using only information about the number *n*.)

3. If 1/*n* is a terminating decimal, what could you say about 2/*n*? About *m*/*n*, if *m* is a counting number less than *n*?

4. What about non-terminating decimals? What patterns do you see with the repeating decimals and the non-repeating decimals?

5. And what about “eventually-repeating” decimals?

What do you want to find out about terminating decimals?

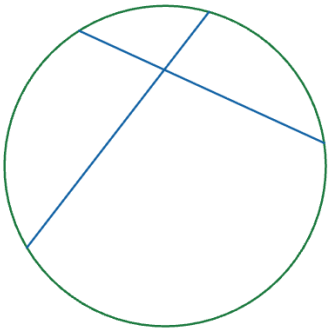
Discuss with your teacher. Set your plan. Have fun. Let us know what you have discovered.

Top

Divided Circle

Consider a circle divided by chords in such a way that every chord intersects all the other chords interior to the circle and no three chords intersect in a common point.

For example, in the picture below is a circle with 2 chords in it.



What patterns and relationships are there as the number of chords increases? Develop questions that you want to explore and have a discussion with your teacher about them.

Note To Teacher:

The question for this problem could be posed in different ways. Please use a variation that matches well with the student. Here are some other options:

> How many chord intersections, chord segments, and regions will there be in a circle divided by 100 chords?
>
> As the number of chords in the circle increases to n, what happens to the number of chord intersections, chord segments, and regions created?

Possible Extensions:

- What happens if you change from a circle to another shape? What changes and what stays the same about your work? How do you know?

- What happens as the radius of the circle increases to infinity? What changes and what stays the same about your work and solution? How do you know?

- What happens if the circle is gone and the chords become lines on a plane? What changes and what stays the same about your work and solution? How do you know?

Section 3:

For Students who struggle in math / who have had an interrupted or limited math education

Top

Jose's Rabbit

Jose is training his pet white rabbit, Blanco, to climb a flight of ten steps. Blanco can hop up 1 or 2 steps each time he hops. He never hops down, only up. How many different ways can Blanco hop up the flight of 10 steps? Can you generalize this for any number of steps?

Top

Cops and Robbers

Robin Banks robs a bank and drives off. A short time later he passes a truck stop at which police officer Willie Katchup is dining. Willie receives a call from his dispatcher and takes off in pursuit of Robin. Two minutes after he passes the truck stop, Robin is 1.5 km away.

Willie takes off and six minutes after Robin has passed, he is 2 km from the truck stop. Seven minutes after Robin passed, Willie is 4 km from the truck stop.

What question(s) would you like to think about and answer?

Top

New Friends and Triangular Numbers

If 5 people meet and shake each other's hand exactly once how many handshakes would there be?

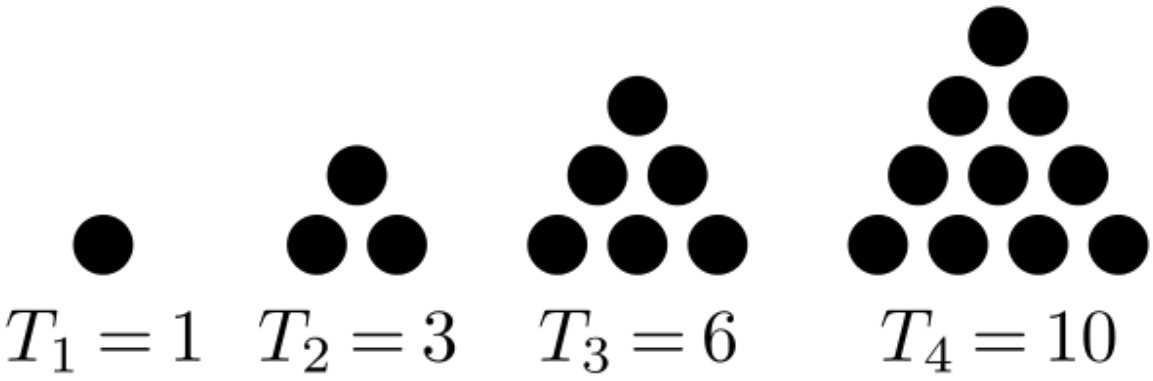
Share all the thoughts you had in trying to find the solution.

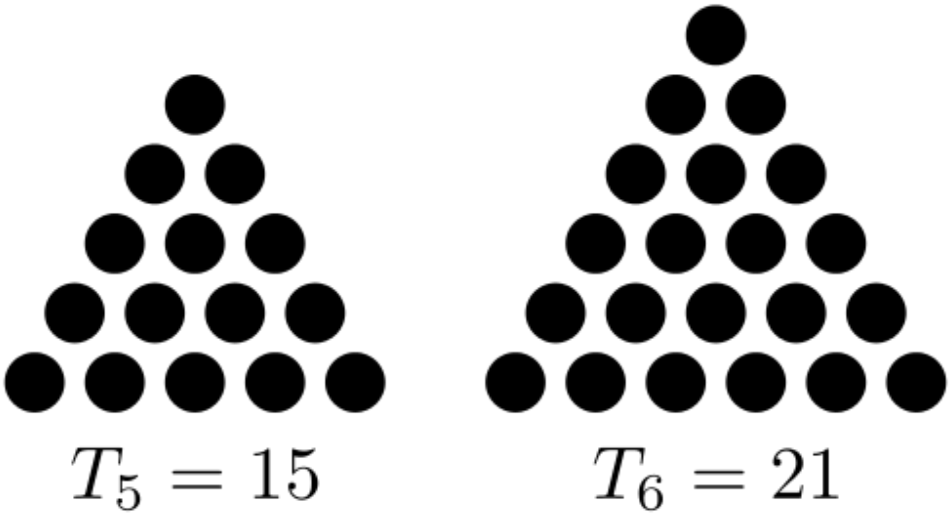
What would happen if there were 10 people?

Can you find a way to answer the question for any number of people?

Now you are going to compare the first problem to Triangular Numbers.

Look at the pattern below….





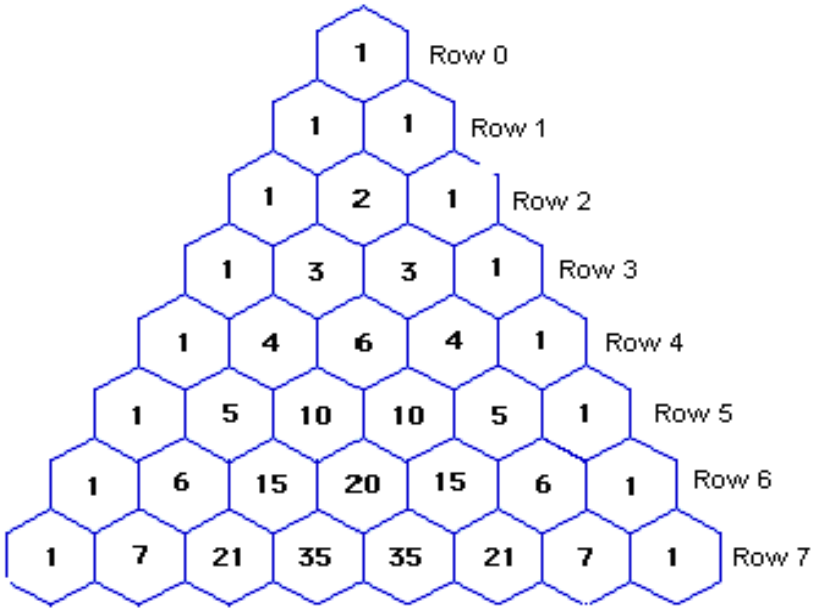
Compare and contrast the two patterns. Create two questions you would like to answer that shows the similarities and differences between these two problems.

Top

Indiana Jones and the Mystery of the Pyramid's Treasure

You and your friend Malik have been selected as game testers to try out a new video game for the Nintendo Wii. Based on the new Indiana Jones movie, the game requires you to crack codes to open secret chambers in a pyramid to find ancient treasure.

- You need to crack a code to open each chamber.
- Each code is based on different patterns.



LEVEL 1

Over time, many layers of the pyramid have worn away, and you cannot see the numbers written on them. To crack the first code, you need to find the missing numbers for Row 8 of the pyramid.

Malik is having trouble beating Level 1. Explain for him how you found EACH of these numbers using words and diagrams.

LEVEL 2

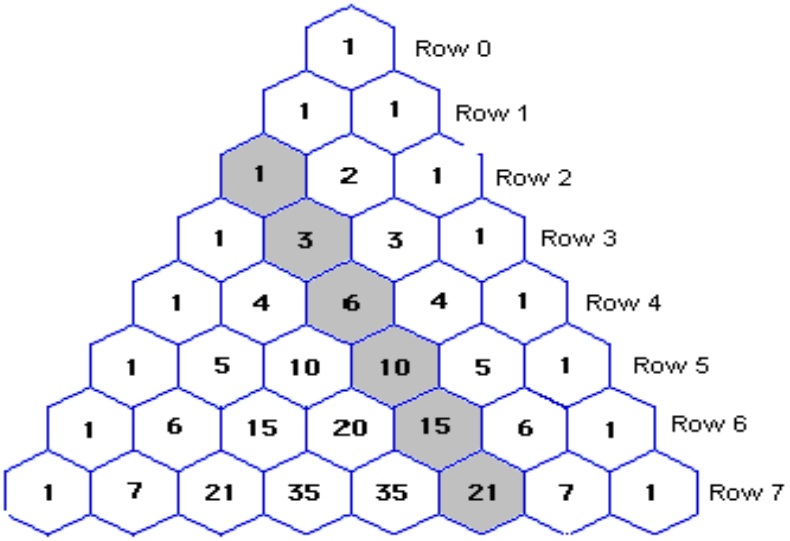
There are many levels of the pyramid buried deep underground. They have numbers, too, but there's no way you could dig down to see them.

Add up the numbers in each row, looking for patterns. To crack the second code, you need to get the **sum** of the numbers written on Row 30.

Malik is having trouble again, and he asks for help. Explain to him how you found your answer using words and diagrams.

BONUS code: Most patterns can be written using a mathematical rule or formula. To open up a secret level, write a rule/formula for the sum of Row N, where N can be any number.

LEVEL 3



At the start of Level 3, one diagonal of the pyramid begins to glow.
To open the third chamber, you need to find the number that would be written in Row 20 of this glowing diagonal.

Malik is having trouble again. Help him out! Explain to him how you found your answer using words and diagrams.

LEVEL 4

Look at Row 0 – Row 4.
Think about the digits forming a number.

In Row 1 you should read 1 1 as eleven.
In Row 2 you should read 1 2 1 as one hundred twenty one.

Do you notice something unique about those numbers? Write down your discovery.
What should Row 5 look like? Why does it look different?

LEVEL 5

Look at Rows 5 and 7 and compare them to Rows 4 and 6
How do they differ in relation to factors and multiples?
What is the next Row that will be similar to Row 5 and 7? Show your evidence by writing the full rows.
Why do you think these rows have this similar pattern?
What do you think would be the next rows that would follow that pattern?

Top

Odds and Evens

What is the sum of the first 100 odd counting numbers? How can you answer without adding up all the numbers?

How can you find the sum of the first 100 even counting numbers without adding them up? What is the sum?

How can you find the sum of the first 100 counting numbers without adding the numbers up? What is the sum?

Generalize the sum of *n* odd counting numbers? *n* even counting numbers? The first *n counting numbers?* What is the connection between the three generalizations?

Top

The Race

Sitting in his math class, Abranny is trying to figure out how he is going to get an A for the year, especially since he has missed handing in so much of the homework. Then, he has a brilliant idea.

Abranny's teacher is always bragging about what a great runner she was in college and how many trophies she won. So Abranny says to his teacher, "I have a cousin who is a pretty good runner. Would you like to race him? He's a little bit younger than you so I bet he would even give you a head start." Abranny dares his teacher and says, "If my cousin beats you, you give me an A in math for the year. If you win, I'll make up all my homework and do any extra work that you give me." Abranny's teacher thinks for a minute, "After I win, I'll be able to get Abranny to catch up on his work." Then she says, "Okay. I'll do it. Who's your cousin?"

Abranny: "Usain Bolt."
Teacher: "*Usain Bolt*! You mean the Jamaican guy who made world records for the 100 and 200 meter races in the 2008 and 2012 Olympics?"
Abranny: "That's rrriiigghhttt. But you can't back out now."
Teacher: "Okay, I'll do it. But I better get a good head start."
Abranny: "Okay. I'll lay out the race for you and I'll make sure you have a good headstart."

The Day of the Race
When the starting buzzer sounds, Abranny's teacher springs from the starting line and tears down the course. Usain takes off some time later.

NOTE: ALL TIMES ARE GIVEN SINCE THE STARTING BUZZER SOUNDED.

The Teacher:
15 seconds after the buzzer, the teacher still has 135 meters to go to the finish line. 32 seconds after he left the starting line, the teacher has only 50 meters more to run.

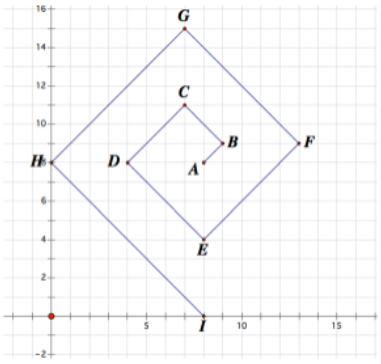
Usain Bolt (Usain starts running at some point after the teacher starts)
22 seconds after the buzzer, Usain is 189 meters from the finish line. 36 seconds after the buzzer, he is 42 meters from the finish line.

BOTH PEOPLE ARE RUNNING AT A CONSTANT SPEED.

Your task is to determine the outcome of the race. You need to explain the process (What did you do and why did you do it?) you use and show all the mathematics. Once you have completed your work discuss the following: What other questions can you now answer based on your work?

Top

The Spiral Alphabet



Based on the pattern shown above, find the coordinates of the following letters:

J: _____

N: _____

R: _____

Z: _____

Is there a shortcut to figuring out these coordinates? If so, how?

What new questions would you like to ask and try to answer?

Top

Powers of 2

Look at these numbers:

1, 2, 4, 8,16, 32, 64,.....

1. What makes these numbers unique?
2. Why are they called powers of 2?
3. Think about the factors of each of the numbers. What do you notice? How does it compare to even numbers that are not powers of 2 or odd numbers? How about powers of 3? powers of 6?

Now you are going to be given two problems based on the powers of 2.
As you work on these problems, think about the uniqueness of these numbers and the meaning of patterns in mathematics.

a) What is the unit digit in the expansion of 2^{1000}?

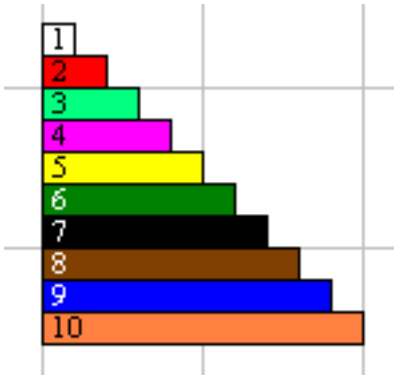
b) What is the remainder when 2^{1000} is divided by 7?

Top

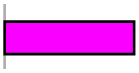
Trains

Cuisenaire rods are a math manipulative that can be used for learning many different types of math: fractions, percents, ratios, integers, etc. For this problem, you will use the various rod lengths to make Cuisenaire rod trains.

Cuisenaire rods come in whole-number lengths of 1 cm up to 10 cm.



Below is a 4 cm rod. We'll call it a 4-unit *train*.



There are 8 different ways to construct a 4-unit train. Here are the 8 ways:



How many different ways can a 10-unit train be constructed?

How many different ways can a *n*-unit train be constructed?

Top

The Three Problems

Question 1: If 5 people meet and shake hands exactly once, how many handshakes would there be?

Share all the thoughts you had in trying to find the solution.
What would happen if there were 10 people?
Can you find a way to answer the question for any number of people?

Now, you are going to compare the first problem with two other problems.

Question 2: How many three-digit numbers are "increasing numbers"?

Increasing numbers are numbers whose three digits are in increasing order. For example,



Are all increasing numbers. There are many more.

Examples of numbers that are not “increasing numbers” are 255, 444, or 351.

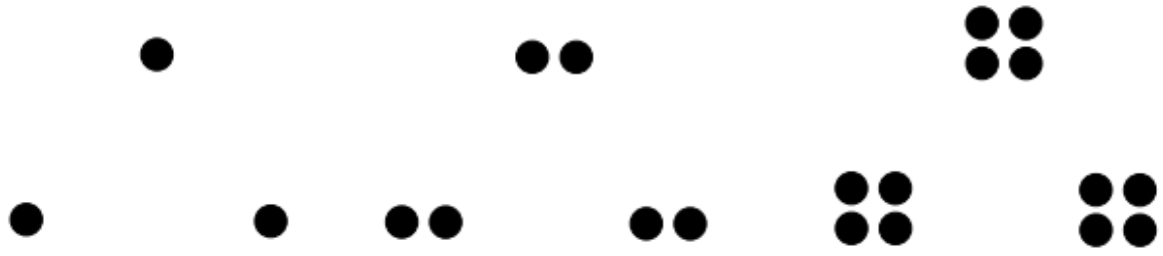
Question 3: What is the sum of the first 100 counting numbers?

Now that you have worked on these three problems, discuss how they are connected to each other. How does each problem help you to understand the other two problems with greater depth?

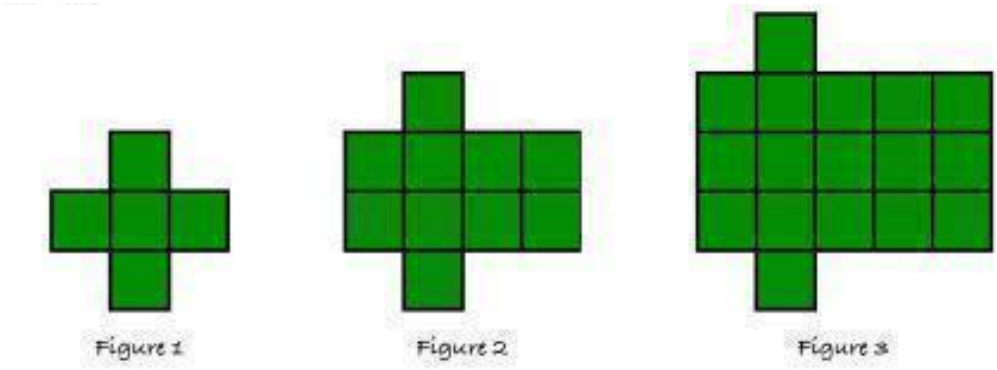
Top

Growing Dots and Growing Objects

Growing Dots



Growing Objects



Take a look at the two patterns…Think about what is happening in each one…Write about everything you can and have discovered.

What do you want to find out about these patterns? Use your best mind to create two challenging questions that you will then try to answer. Share your questions with your teacher before you move further in your deep investigation.

Top

Pizza Pizza Pizza!

Your local pizza shop, Luigi's Pizzeria, offers up to four toppings on its pizzas: pepperoni, spinach, mushroom, and pineapple.

Determine how many different pizzas can be made. How do you know you have found all of them? What happens if you are limited to *any* number of toppings?

Use your greatest mathematical mind to explore the patterns and connections within. Write about everything you can and have discovered.

Extension#1:

Powers of 2

Look at these numbers:

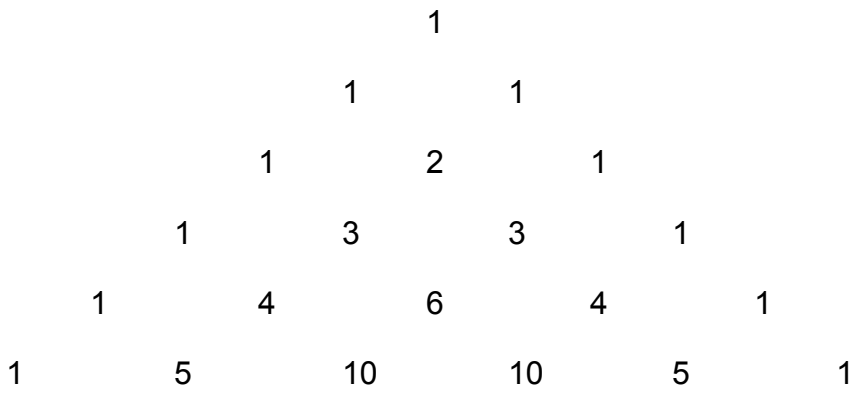
1, 2, 4, 8,16, 32, 64,.....

1. What makes these numbers unique?
2. Why are they called powers of 2?
3. Think about the factors of each of the numbers. What do you notice? How does it compare to even numbers that are not powers of 2 or odd numbers?

What is the unit digit in the expansion of how many different pizzas can be made from 1000 toppings?

Extension#2:

If the number of pizzas are separated out and arranged in rows like this, you have discovered what's commonly referred to as **Pascal's Triangle****.



There are many patterns to discover in Pascal's triangle. What do you want to find out about this? Use your best mind to create two challenging questions that will show the relationship between these two problems. Share your questions with your teacher before you move further in your deep investigation.

**The Arithmetic Triangle has fascinated mathematicians for thousands of years. It fascinated Indian and Persian mathematicians in the 10th century and Chinese mathematicians in the 11th century, and it still fascinates today. As such, it has different names depending on geography & time period: the Staircase of Mount Meru in India, the Khayyam Triangle in Iran, Yang Hui's Triangle in China, Tartaglia's Triangle in Italy, and the Arithmetic Triangle in Europe before the 17th century, and Pascal's Triangle in many, primarily Western, countries after the 17th century, due to his work compiling and organizing its many properties and explicitly connecting it to probability theory and binomial expansion. For a brief history of the triangle, here's a short video ~2 min.

Note to Teacher:
Please share with your student that the triangle has had many different names throughout history and feel free to use whichever name makes the most sense to you and your student. For a brief history on the triangle, here's a short video ~2 mins.