Curiosity Driven Mathematics

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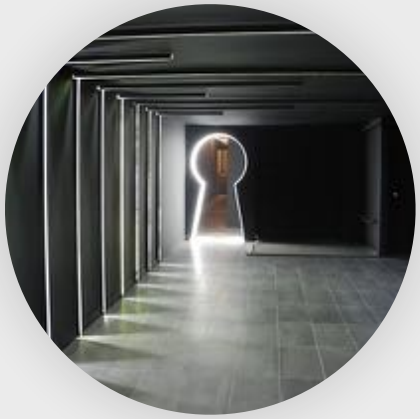
My Mission

Make Math Irresistible for Students & Teachers

Three Things I'm Thinking About



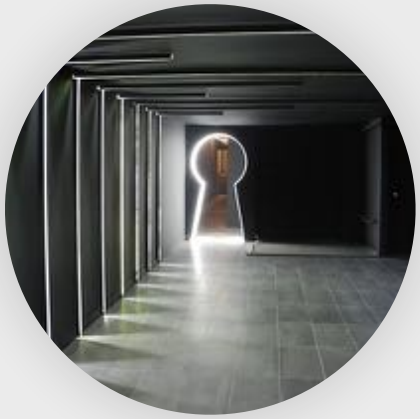
Escape Rooms

Magic

Mysteries

People from All Walks of Life are Drawn to These Activities

Why are These Activities Irresistible?



Escape Rooms

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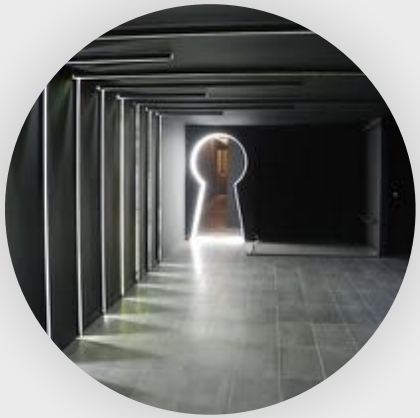
At the Core



A set of problems to be solved under a time constraint.

Isn’t this a TEST?

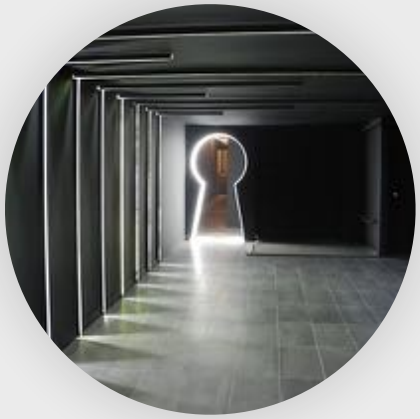
Performance designed to deceive you via misdirection, etc.

It’s FAKE!

A story told in reverse with info withheld. The butler did it.

Any questions?

Why are These Activities Irresistible?



Escape Rooms

Magic

Mysteries

What are the Irresistible Elements?

Problems to Solve

Immersed in a Story

Intermittent Clues

A Solution or Explanation Exists

Intellectual Surprise

Intellectual Surprise

When confronted with intellectual surprise…

We get curious!

Humans have an innate drive to solve problems and seek truth

Curiosity Enhances Learning

During states of high curiosity learning and memory are enhanced (Gruber, 2014)

Curiosity greatly influences academic performance (Von Stumm, 2011)

A small investment in sparking curiosity can last an hour and lead to stronger outcomes

My Favorite Math Moments

My favorite problems feature surprise answers, surprise connections, or surprise insights

My favorite teaching moments aren't the "aha" moments

My favorites are the "Wait, WHAT?!" moments

Crazy Subtraction

$$\begin{array}{r} 873 \\ -\ 369 \\ \hline 51\text{-}6 \end{array}$$

What are You Wondering?

Crazy Subtraction

$$\begin{array}{r} 873 \\ -\ 369 \\ \hline 51\,\text{-}6 \end{array}$$

$$500 + 10 - 6 = 504$$

Quadrilaterals

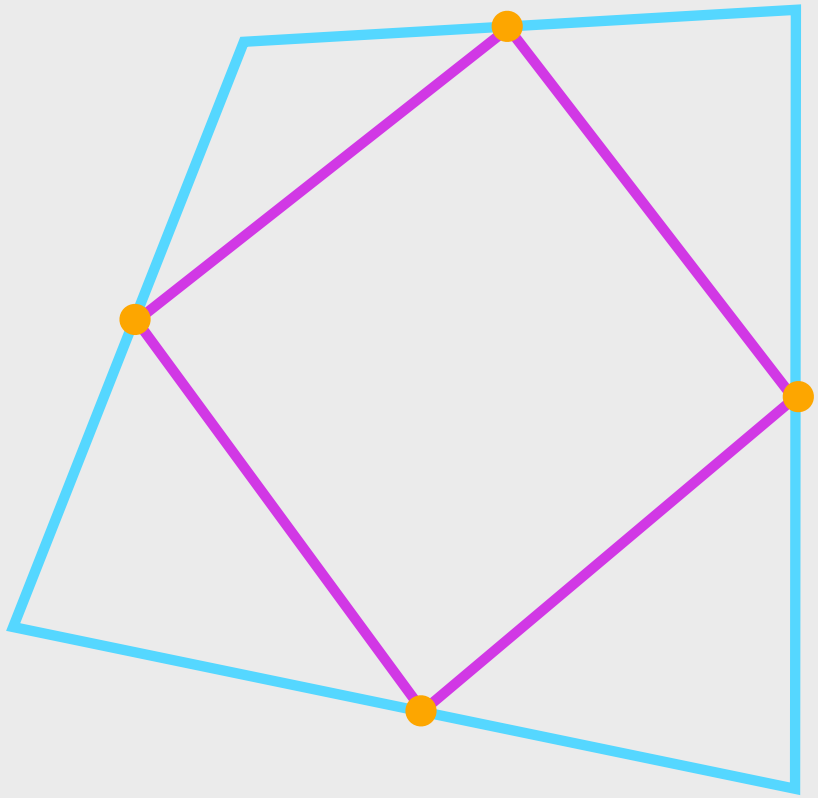
Draw a quadrilateral

Mark midpoints of each side

Connect adjacent midpoints

What do you notice about

the new quadrilateral?



Good News!

Math is full of surprises!

They are everywhere you look. Really, they are!

Familiarity causes us to overlook them.

Can Math Be Irresistible?

Problems to Solve

Story

Intermittent Clues

A Solution or Explanation Exists

Intellectual Surprise

Why Isn’t Math Class Full of Surprises?!

COMMON CORE STATE STANDARDS FOR Mathematics

COMMON CORE STATE STANDARDS INITIATIVE
PREPARING AMERICA'S STUDENTS FOR COLLEGE & CAREER

Operations and Algebraic Thinking 3.OA

Represent and solve problems involving multiplication and division.

1. Interpret products of whole numbers, e.g., interpret 5 × 7 as the total number of objects in 5 groups of 7 objects each. *For example, describe a context in which a total number of objects can be expressed as 5 × 7.*
2. Interpret
3. Use multi
4. Determin

Understand p
between mul

5. Apply pro
6. Understar

Multiply and

7. Fluently

Solve proble
explain patte

8. Solve two
9. Identify a

Congruence G-CO

Experiment with transformations in the plane

1. Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.
2. Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch).
3. Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself.
4. Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.
5. Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, e.g., graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.

Understand congruence in terms of rigid motions

6. Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure; given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent.
7. Use the definition of congruence in terms of rigid motions to show that two triangles are congruent if and only if corresponding pairs of sides and corresponding pairs of angles are congruent.
8. Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions.

Prove geometric theorems

9. Prove theorems about lines and angles. *Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent; points on a perpendicular bisector of a line segment are exactly those equidistant from the segment's endpoints.*
10. Prove theorems about triangles. *Theorems include: measures of interior angles of a triangle sum to 180°; base angles of isosceles triangles are congruent; the segment joining midpoints of two sides of a triangle is parallel to the third side and half the length; the medians of a triangle meet at a point.*
11. Prove theorems about parallelograms. *Theorems include: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals.*

Make geometric constructions

12. Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). *Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.*
13. Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.

31 Noel read 90 minutes each day for 6 days. Tyra read 60 minutes each day for 8 days. What is the difference, in minutes, between the total amount of time Noel read and the total amount of time Tyra read?

A 30

B 40

C 60

D 80

17 The picture below shows that one box is heavier t

The box has a mass of 40 kilograms. What could be the mass, in kilograms, of 1 can?

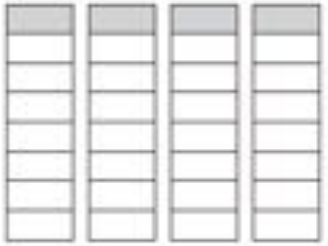
A 40

B 10

C 8

D 6

Which multiplication sentence can be used to calculate the total shaded area shown in the model below?



A $4 \times \frac{1}{8} = \frac{?}{}$

B $8 \times \frac{1}{4} = \frac{?}{}$

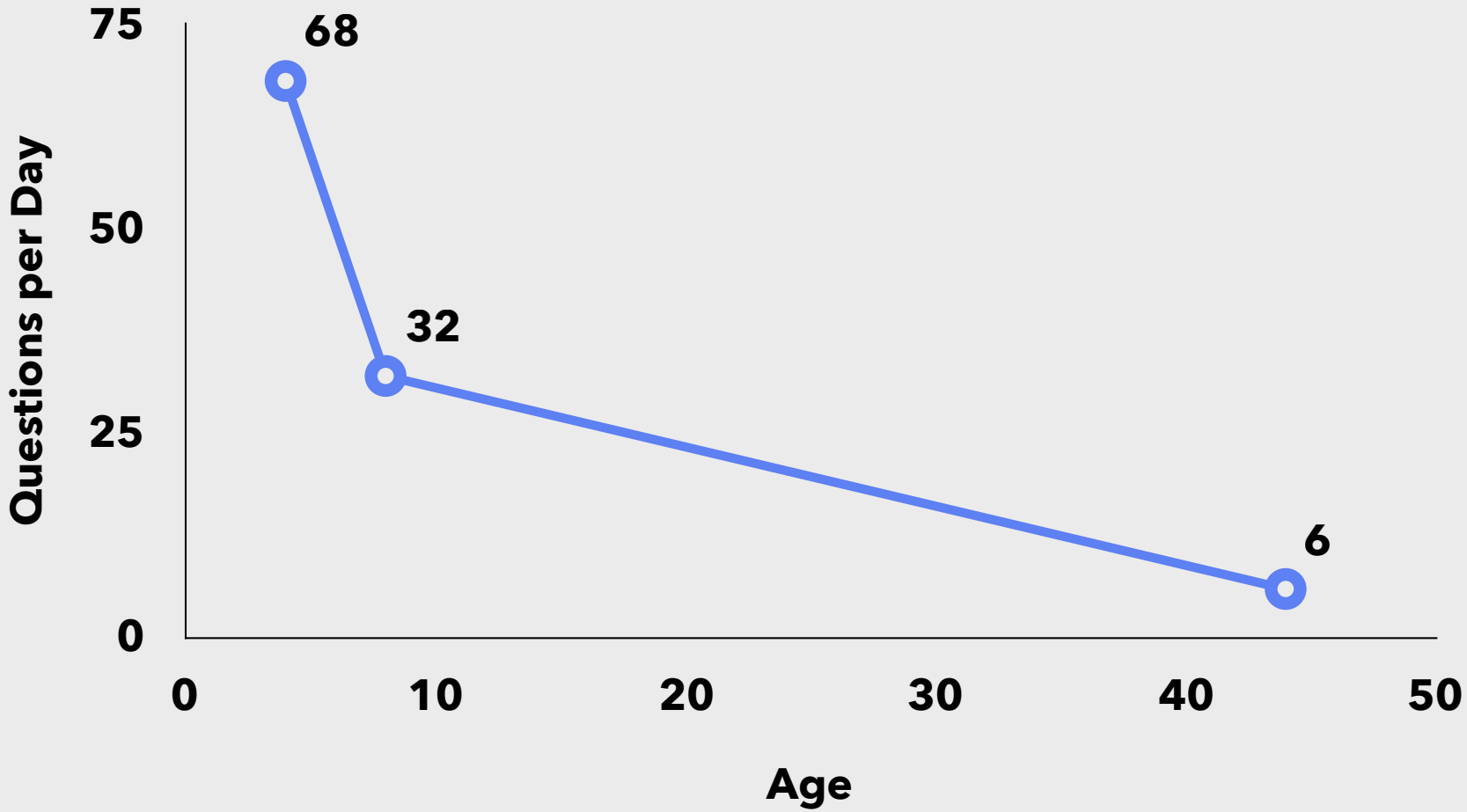
C $4 \times \frac{1}{6} = \frac{?}{}$

D $6 \times \frac{1}{4} = \frac{?}{}$

> The biggest problem in education is the giving of answers to questions that have not yet been asked.

DR. ARTHUR COMBS

Questions Asked Per Day



The Solution

Stop ignoring everything we know about psychology!

Don’t assume kids will learn just because we told them!

It is our responsibility to spark their curiosity!

How to Spark Curiosity

Create a gap between what is known and unknown

Ways to Create Gaps

Surprise
Story
Mystery
Questions
Conflict

Engineering Surprise

Identify the mystery / discovery / surprise

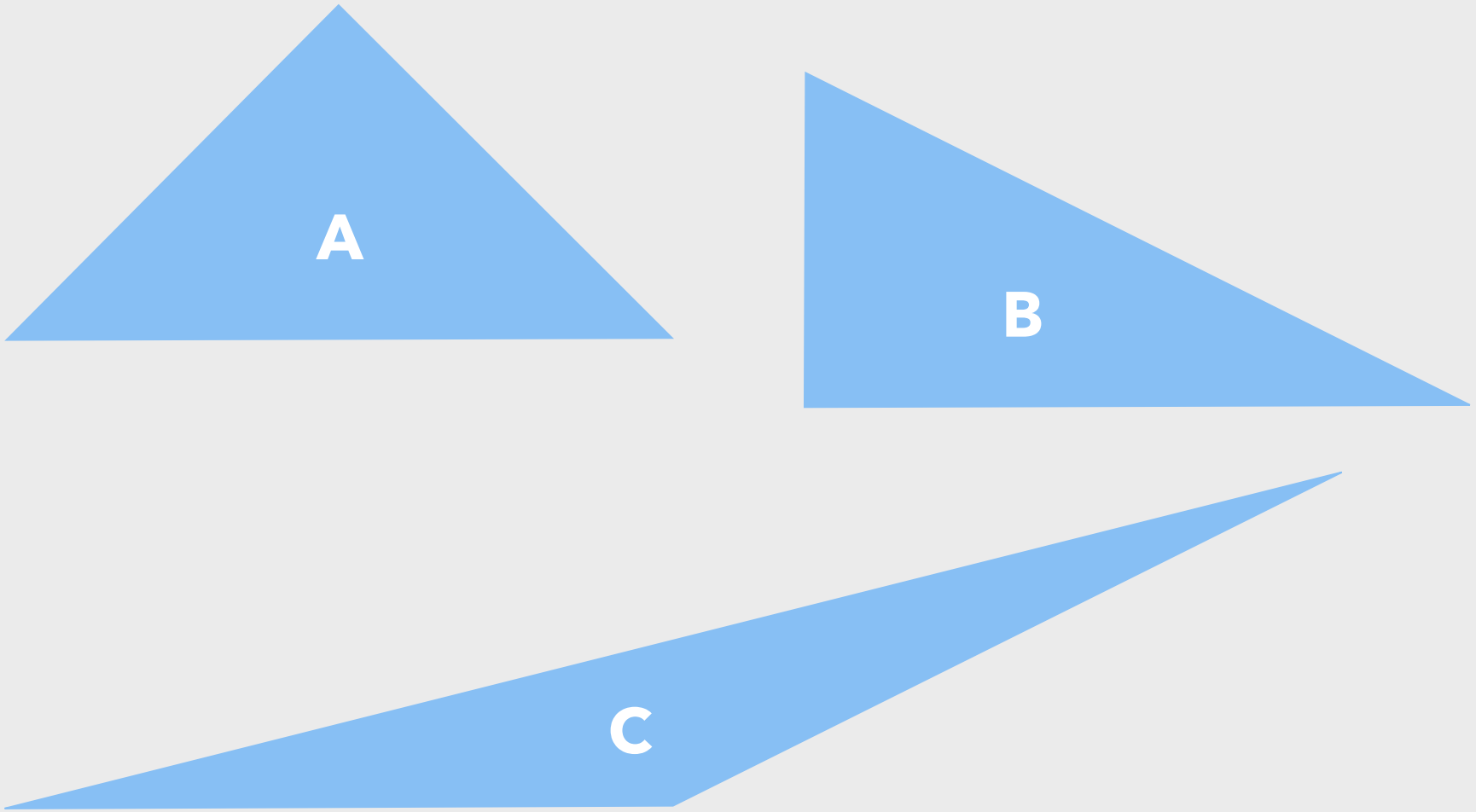
Create an expectation

Shatter that expectation

Engineering Surprise

To a young mind almost everything in math should be surprising!
Find the elements that you could convince someone are surprising.

Which Triangle Has the Largest Area?



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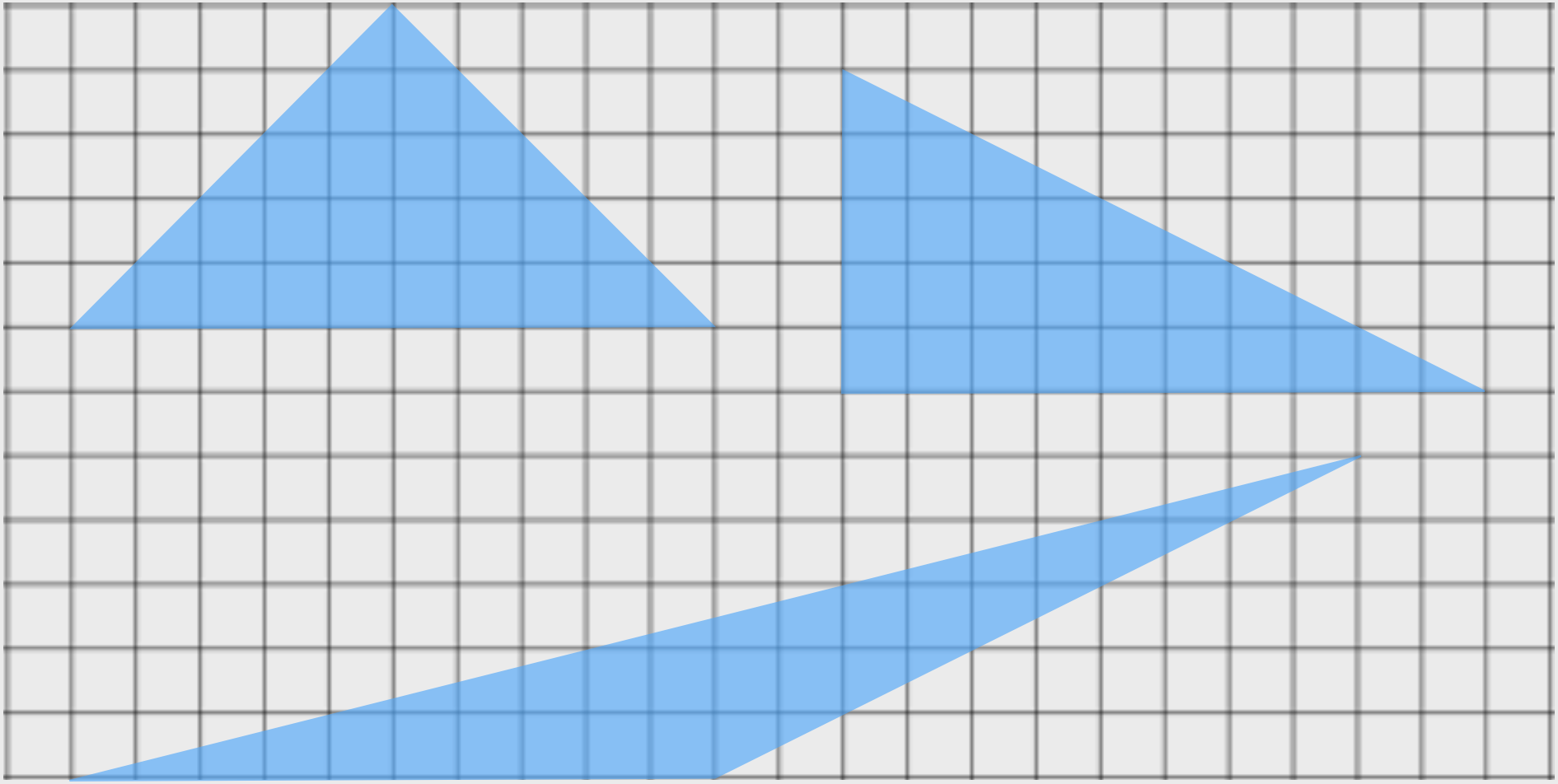

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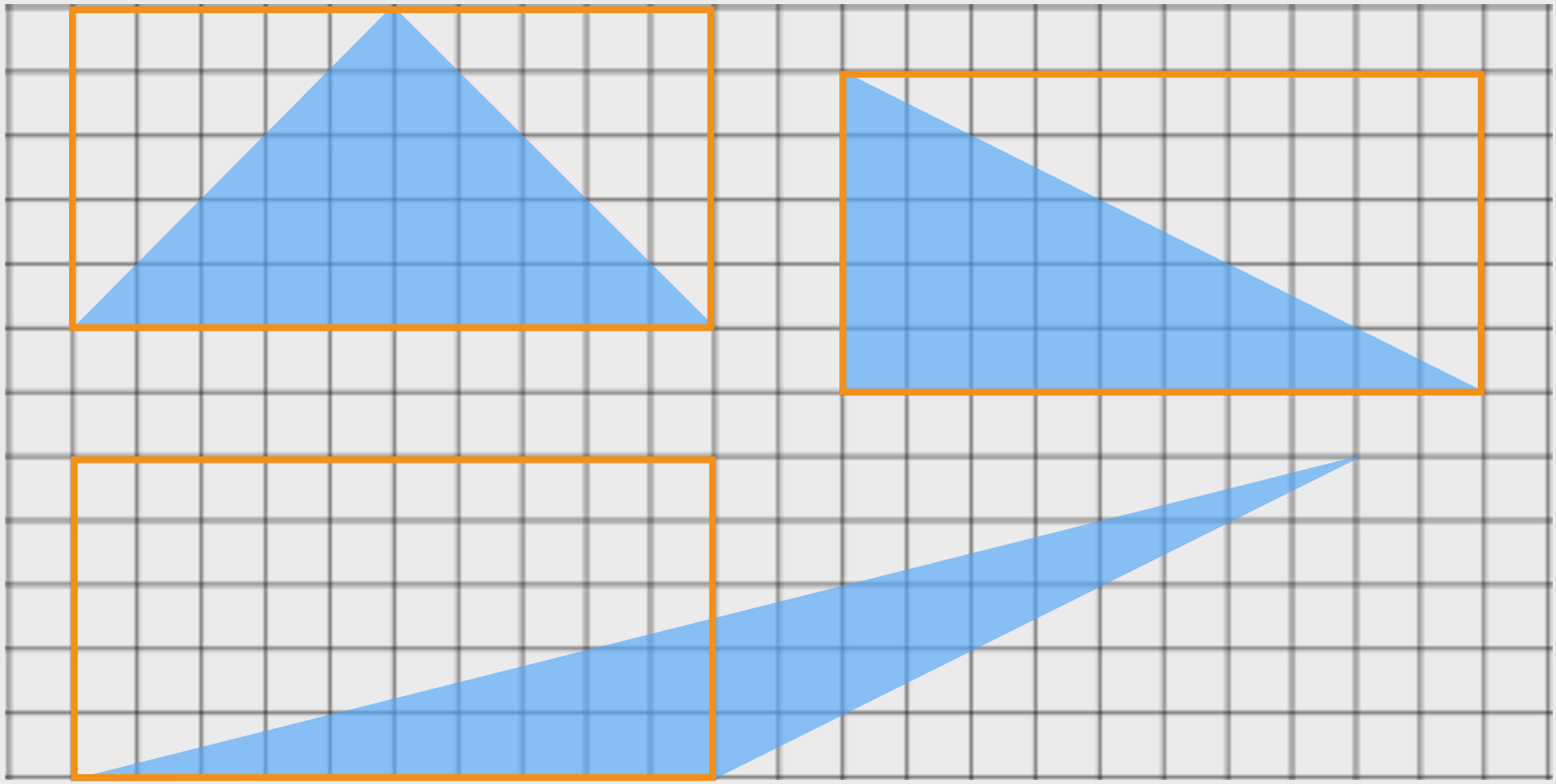

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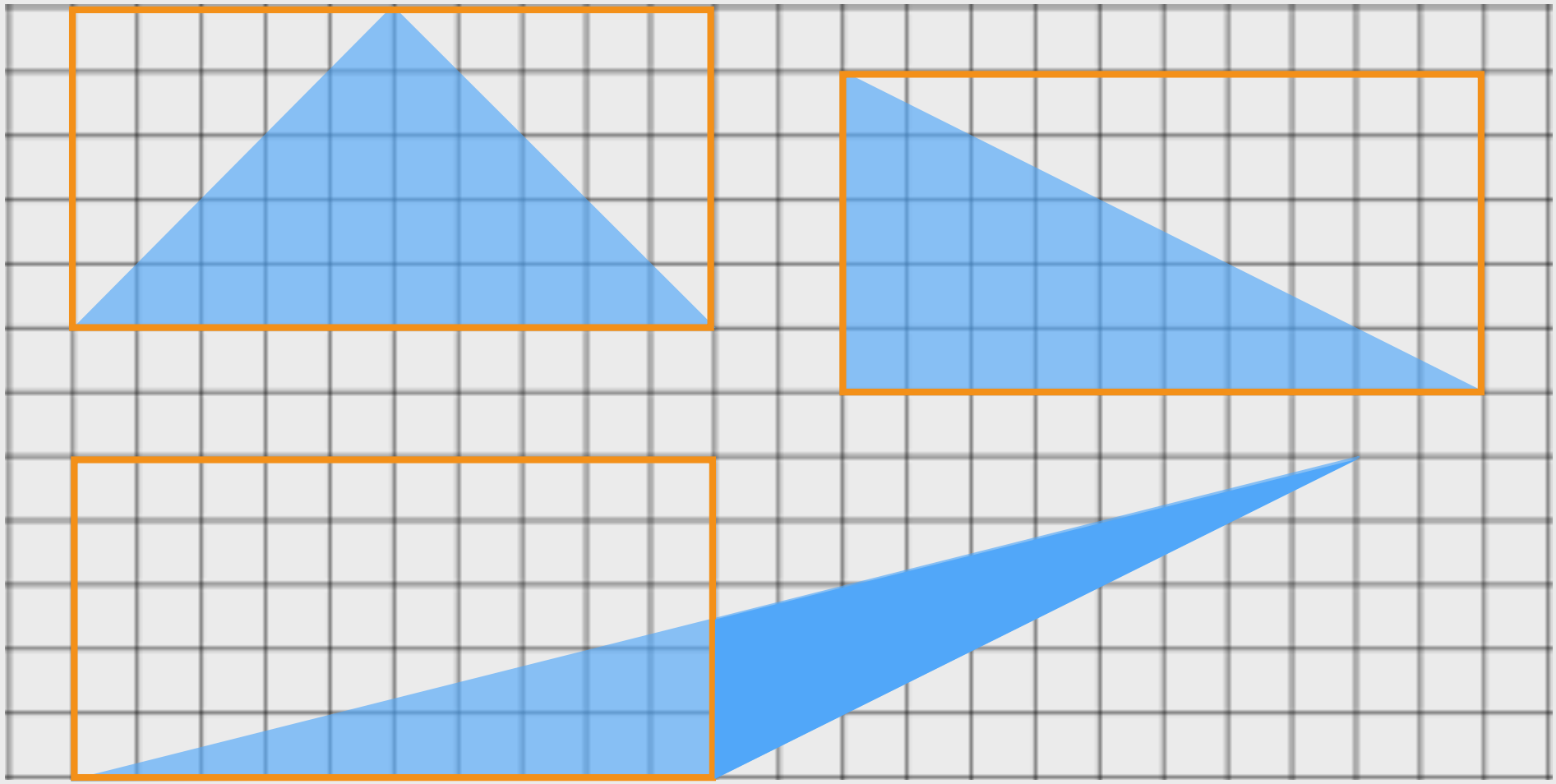


Number Patterns

Choose any two digit number (where digits are different)

Reverse the digits

Find the difference between them. Call this number ‘A’.

Reverse the digits of A and add them back to A

Questions?

Opportunities for Surprise

A common property for a large collection of objects

- All triangles have area = 1/2 base*height
- All quadrilaterals have sum of interior angles = 360
- All multiples of 9 have digit sum = 9

A counter-intuitive result

- Monty Hall problem
- Birthday paradox
- A 10% drop followed by a 10% increase isn’t 100%

Stories

Historical

Mathematical

Gauss

Gauss was ornery in school. As a punishment he was asked to add 1+2+3+ …+99+100.

Gauss solved it in a flash!

Questions

Start with a scenario

Ask students…

What do you notice?

What do you wonder?

Broken Calculator

Broken Calculator

What is the largest number you can’t make on this calculator?

Create Conflict

Would You Rather...?

regular size
regular price

1/3 off the
regular price

or

1/3 more at
regular price

Would You Rather...

Receive 15% of $70 or 70% of $15?

Get $10 for rolling a 5 on a 6-sided die or get $3 for rolling a prime number?

Find 15% of $70 using [a] proportions [b] multiplying decimals or [c] some other method (Explain)

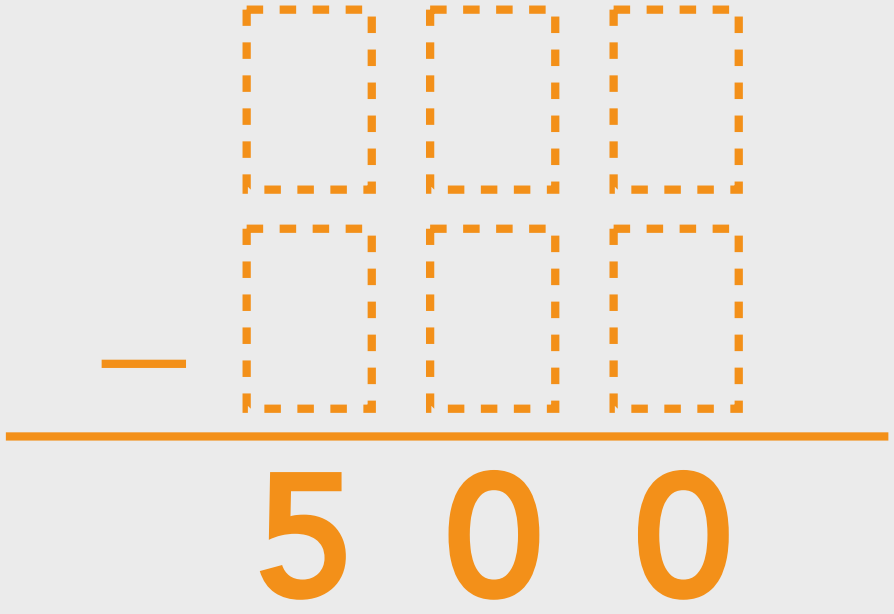
Mystery

Invert the problem

Withhold Information

Open Middle

Fill in the boxes with the numbers 1-9 to create a difference as close to 500 as possible. You may only use each number once.



(ROBERT KAPLINSKY - OPENMIDDLE.COM)

Patterns

$$1 = 1$$

$$1 + 3 = 4$$

$$1 + 3 + 5 = 9$$

$$1 + 3 + 5 + 7 = 16$$

$$1 + 3 + 5 + 7 + 9 = 25$$

Ways to Create Gaps

Surprise
Story
Mystery
Questions
Conflict

Tips to Maintain Momentum

Problems must seem solvable to everyone

Clues must be intermittent otherwise students will give up

Let the kids be the hero in the story

All thinking stops once they have the answer

Call to Action

Seek out Moments for Surprise

Get Kids Curious

Make Math Irresistible

Thank you for attending today's session!

Learn more at www.mheonline.com/mathforall_rshah