Hall County Schools

Robert Kaplinsky
July 29, 2014

IVE

FOX
NEWS

Junction

- Pro
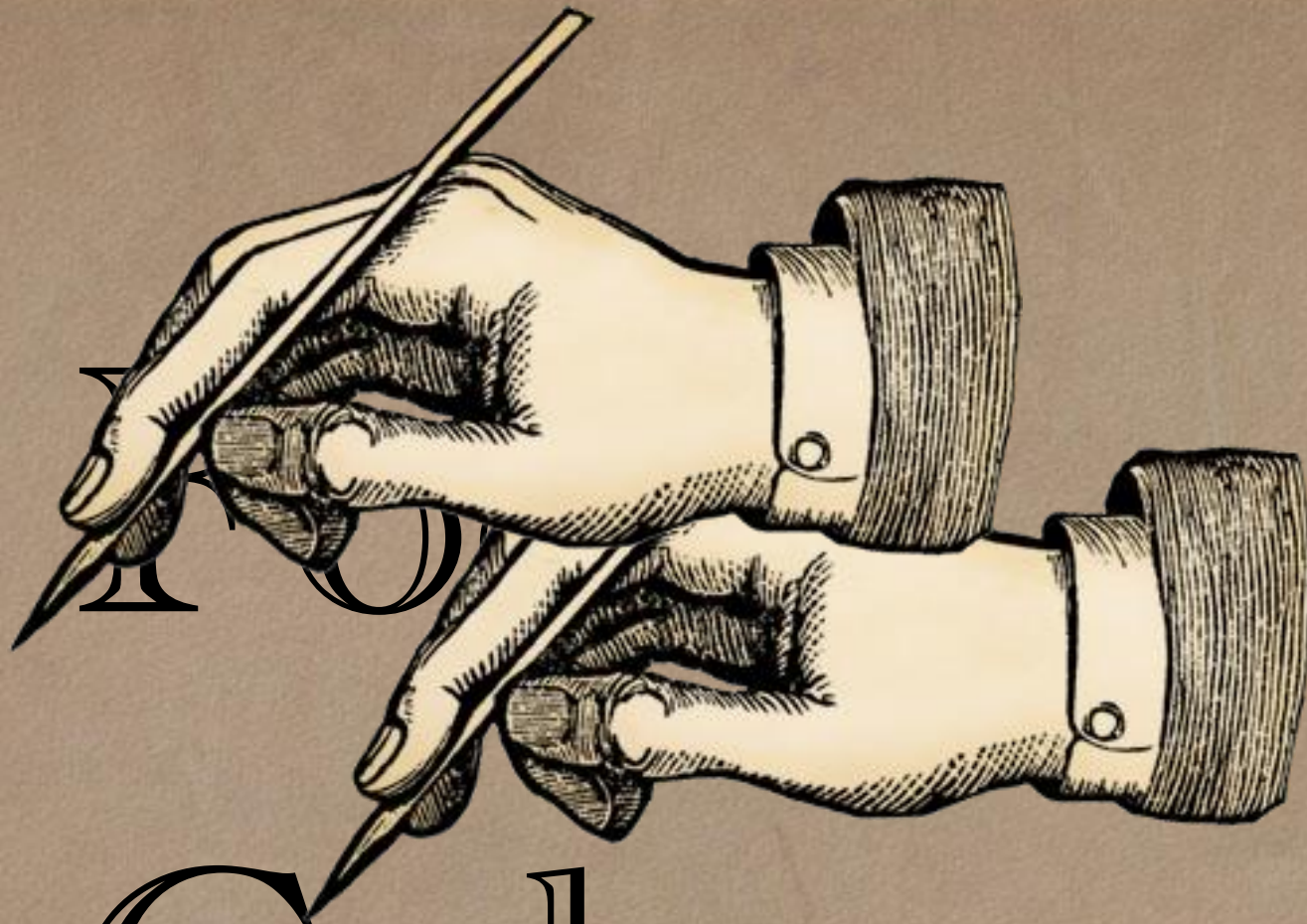
- Coherence

Solving Real-World Geometry Problems

High School

- G-MG.1 – Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).
- G-GMD.3 – Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.

Middle School

- 8.G.9 Know the formulas for the volumes of cones, cylinders, and spheres and use them to solve real-world and mathematical problems.
- 7.G.6 – Solve real-world and mathematical problems involving area, volume and surface area of two- and three-dimensional objects.
- 6.G.2 –Apply the formulas $V = l\,w\,h$ and $V = b\,h$ to find volumes of right rectangular prisms with fractional edge lengths in the context of solving real-world and mathematical problems.

Elementary School

- 5.MD.5 – Relate volume to the operations of multiplication and addition and solve real world and mathematical problems involving volume.
- 4.MD.3 – Apply the area and perimeter formulas for rectangles in real world and mathematical problems
- 3.MD.7d – Find areas of rectilinear figures by decomposing them into non-overlapping rectangles and adding the areas of the non-overlapping parts, applying this technique to solve real world problems.
- 2.MD.1 – Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes.
- 1.MD.2 – Express the length of an object as a whole number of length units.
- K.MD.1 – Describe measurable attributes of objects, such as length or weight. Describe several measurable attributes of a single object.

- Focus
- Coherence
- Rigor
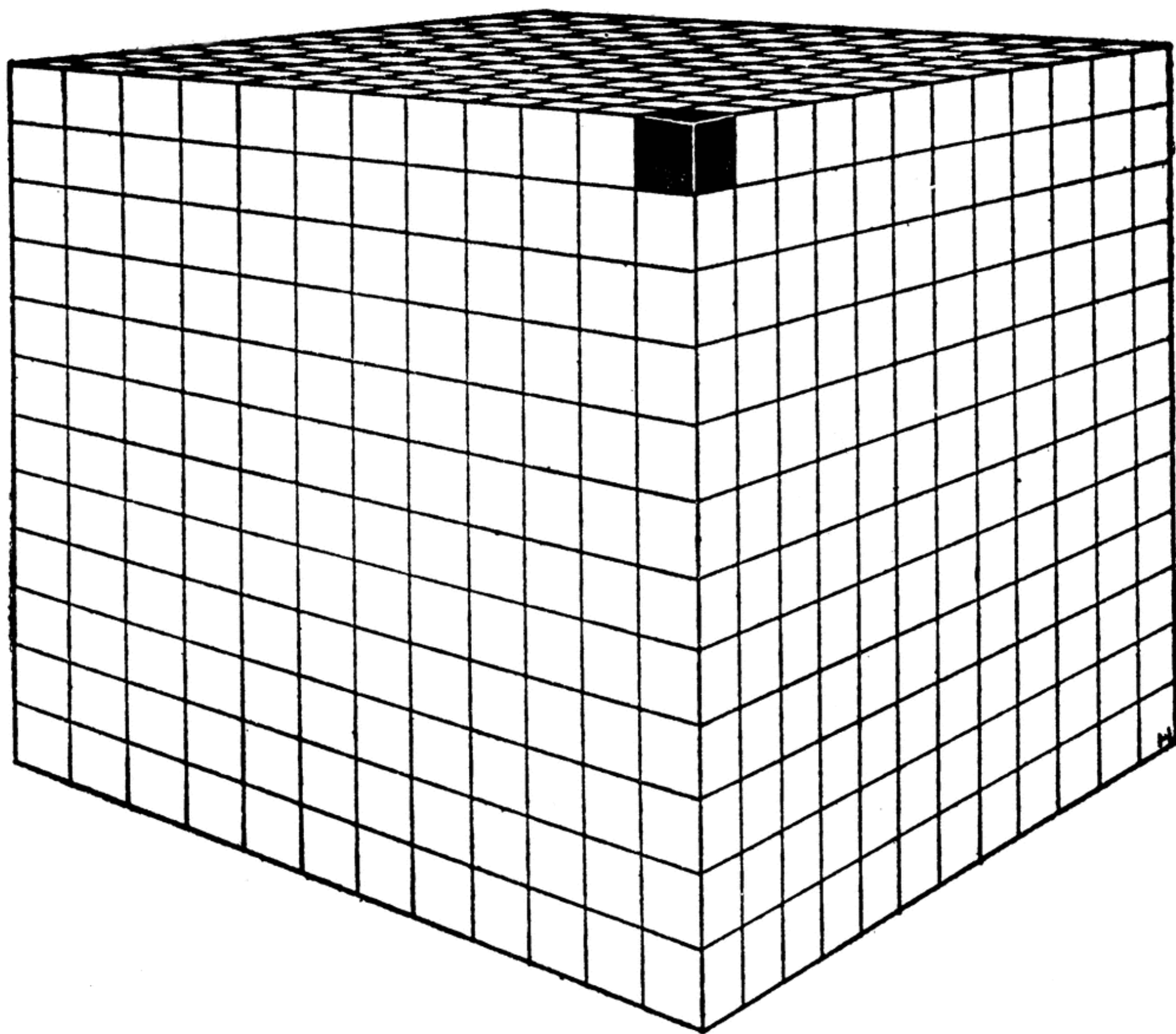
Standards for Mathematical Practice

1. Make sense of problems and persevere in solving them.

2. Reason abstractly and quantitatively.

3. Construct viable arguments and critique the reasoning of others.

4. Model with mathematics.

5. Use appropriate tools strategically.

6. Attend to precision.

7. Look for and make use of structure.

8. Look for and express regularity in repeated reasoning.

BEHR PREMIUM PLUS
LIFETIME GUARANTEE*

EXTERIOR
Semi-Gloss Enamel
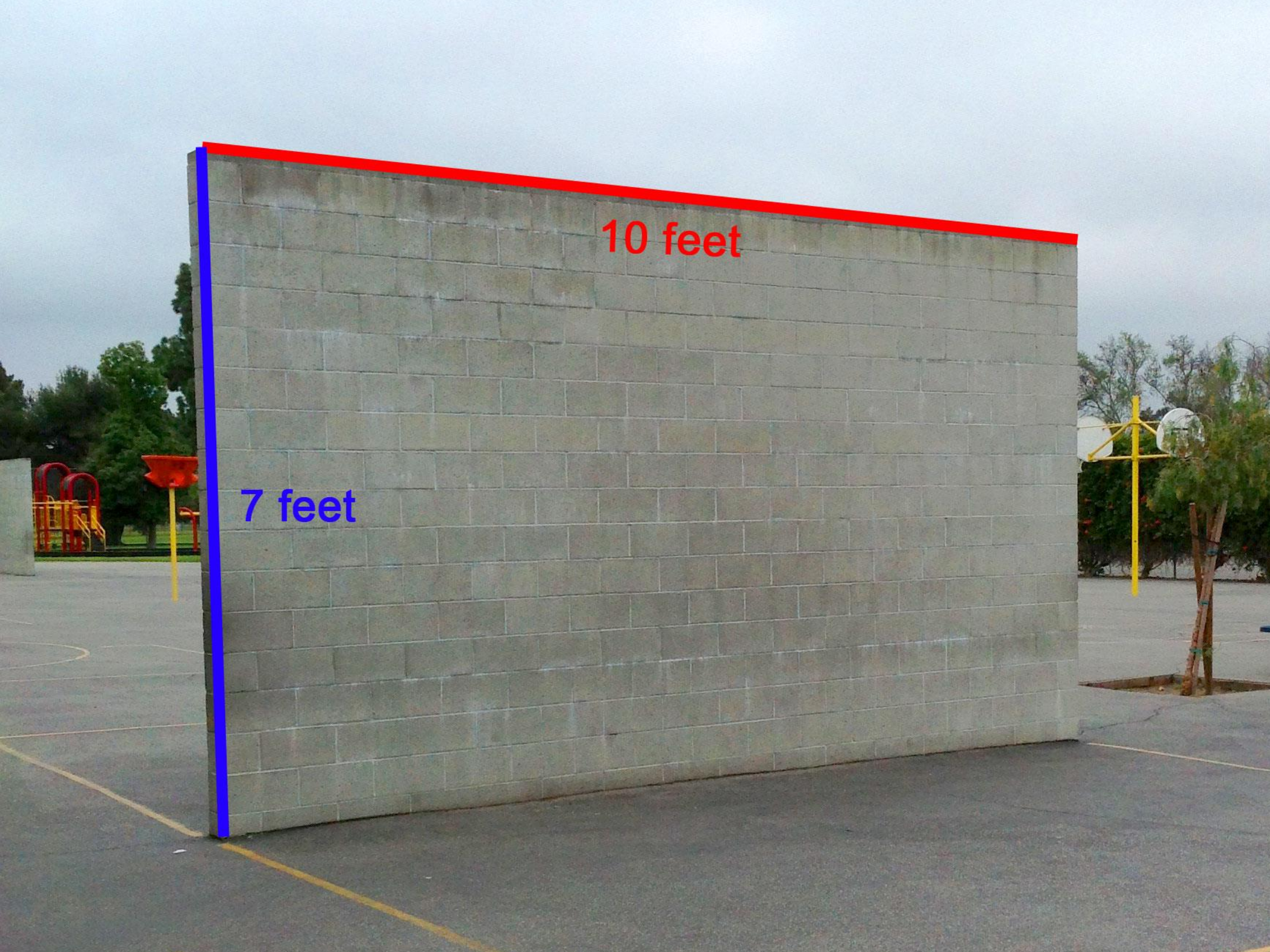ESMALTE SEMI-BRILLANTE EXTERIOR

HARD, DURABLE FINISH
ACABADO FUERTE, DURABLE

The Challenge

Do we have enough paint to cover the handball wall?

The Challenge

How can we figure out if we have enough paint to cover the handball wall?

SPECIFICATIONS

Color	Tintable	Color Family	Whites
Container Size	1 QT-Quart	Coverage Area (sq. ft.)	100 ft²
Exterior Paint & Stains Product Type	Siding & Trim	Low Temperature	No
Manufacturer Warranty	Limited Lifetime Guarantee	Minimum Temperature for Use (F)	50.0

- 3.MD.7d – Find areas of rectilinear figures by decomposing them into non-overlapping rectangles and adding the areas of the non-overlapping parts, applying this technique to solve real world problems.
- 4.MD.3 – Apply the area and perimeter formulas for rectangles in real world and mathematical problems

STUDENT WORK SAMPLES

Do I have enough paint to cover the front of the handball wall? **Explain** how you know.

Yes because 100 - 70 = 30 and 100 - 30 = 70. We had 30 left over. We have 70 square feet on are handball court, and 30 square feet left over.

Do I have enough paint to cover the front of the handball wall? **Explain** how you know.

Yes! Becuse we couted 7 times ten and we got 70.

The Reality

- The question matters
  - Initially we asked students, "Do we have enough paint to cover the handball wall?"

- A few students immediately shouted out "Yes!"
  - I asked them to prove to me that they were correct using a drawing or tiles and many were initially unable to do so.

- Students had trouble articulating themselves in writing
  - Many students struggled with their explanations and will need extensive practice to improve.
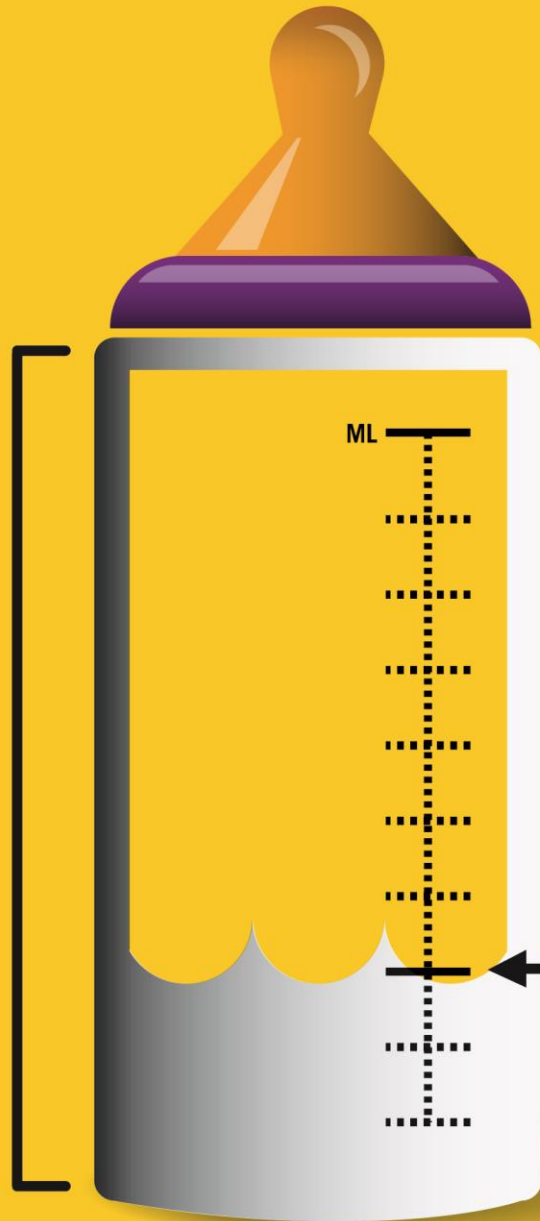
THE NUMBER
OF PEOPLE
**WHO
THINK**
THEY HAVE
THEIR CHILD IN
THE RIGHT
SEAT.

ML

THE ONES
**WHO
ACTUALLY
DO.**

KNOW FOR SURE
IF YOUR CHILD IS IN THE RIGHT CAR SEAT.

Ad Council

VISIT SAFERCAR.GOV/THERIGHTSEAT

NHTSA
www.nhtsa.gov

Child Car
Safety

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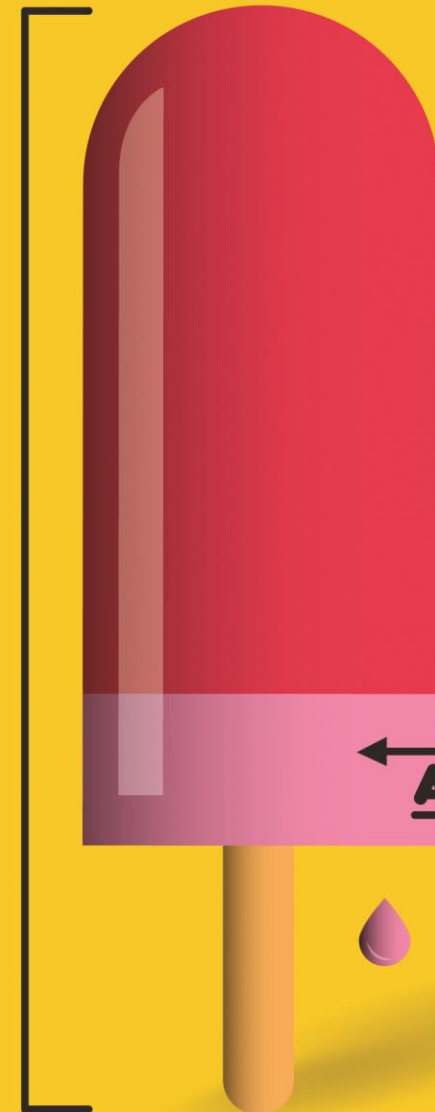
VISIT SAFERCAR.GOV/THERIGHTSEAT

Ad Council

NHTSA
www.nhtsa.gov

Child Car
Safety

Math Question

- Solve the problem on your own. Do not work or share your answer with anyone else.

- You will have 30 seconds to complete it.

- Write your answer down on a paper.

- Pay attention to the emotions you feel while solving the problem and write those emotions down as well.

There are 125 sheep and 5 dogs in a flock. How old is the shepherd?

What does a blackfly
chart students make
sense of problems?

Of the 32 students I interviewed…

- 75% of them gave me numerical responses
- 2 students calculated the answer to be 130 (125 + 5)
- 2 students calculated the answer to be 120 (125 – 5)
- 12 students calculated the answer to be 25 (125 ÷ 5)
- 0 students calculated the answer to be 625 (125 x 5)
- 4 students stated that they guessed their answer (90, 5, 42, and 50)
- 4 students tried to divide 125 by 5 but could not correctly implement the procedure

Takeaways

- Making sense of mathematics

- Intellectual autonomy

  - Intellectual autonomy is about being able to think for yourself and not being dependent on others for the direction and control of one's thinking.

What Does the NHTSA Say?

Key Statistics and Consumer Insights:

- Motor vehicle crashes are the leading cause of death for children age 1 through 12 years old.[1]

According to a NHTSA study, 3 out of 4 kids are not as secure in the car as they should be because their car seats are not being used correctly.
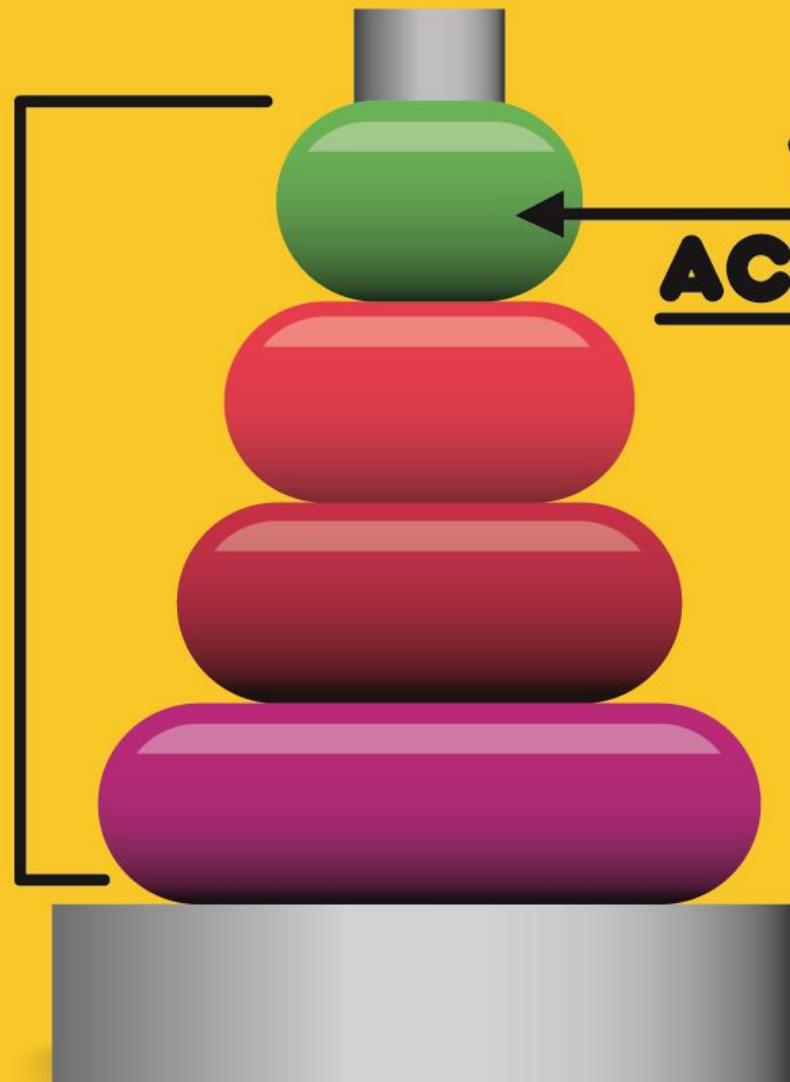
be reduced by about half if the correct child safety seats were always used.

[1] Source: Based on the latest mortality data currently available from the CDC's National Center for Health Statistics.

- "because they have their child in the right seat"
- "because their car seats are not being used correctly"

THE NUMBER OF PEOPLE **WHO THINK** THEIR CAR SEATS ARE BEING USED CORRECTLY.

THE ONES **WHO ACTUALLY DO.**

CHOOSE CAR SEAT: BY AGE & SIZE

ML

KNOW FOR SURE
IF YOUR CHILD IS IN THE RIGHT CAR SEAT.

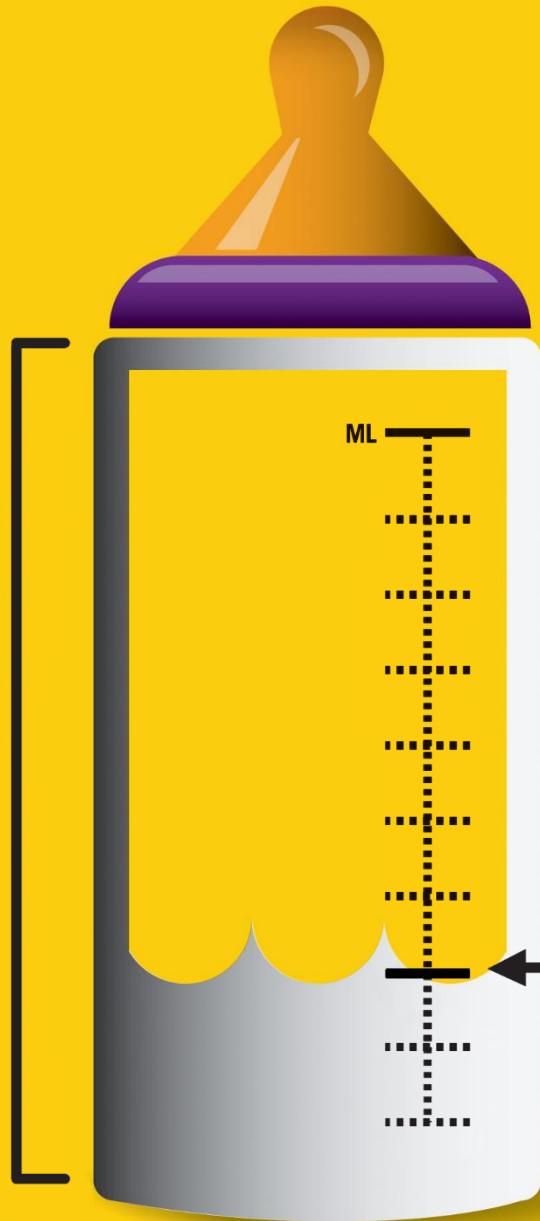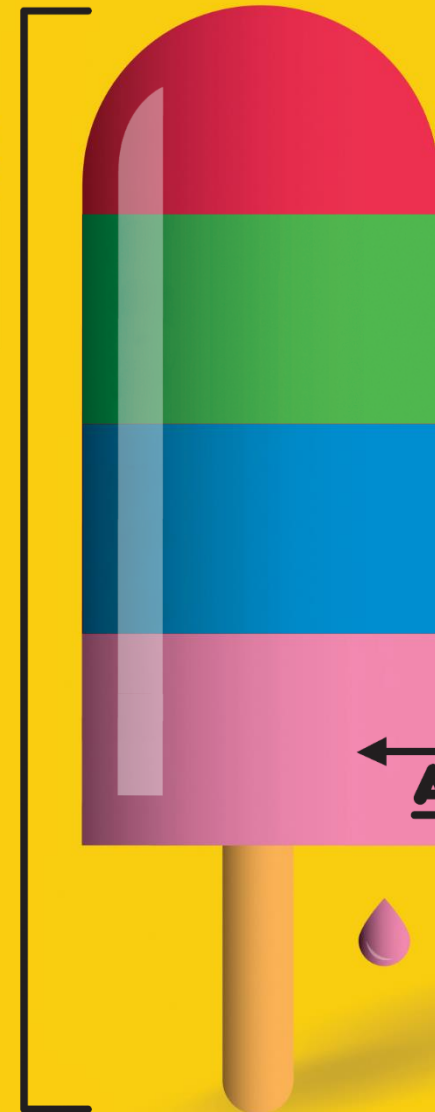Ad Council

VISIT SAFERCAR.GOV/THERIGHTSEAT

★★★★★ NHTSA www.nhtsa.gov

Child Car Safety

THE NUMBER OF PEOPLE **WHO THINK** THEIR CAR SEATS ARE BEING USED CORRECTLY.

THE ONES **WHO ACTUALLY DO.**

CHOOSE CAR SEAT: BY AGE & SIZE

KNOW FOR SURE
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VISIT SAFERCAR.GOV/THERIGHTSEAT

Ad Council

★★★★★ NHTSA www.nhtsa.gov

Child Car Safety

The Challenge

- 4.MD.2 – Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving simple fractions or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit.

Your friend is sick and has to take medicine five times a day for seven days. What times should your friend take her medicine?

WHAT ISN'T MATHEMATICAL MODELING?

- *It is not modeling in the sense of, "I do; now you do."*

- *It is not modeling in the sense of using manipulatives to represent mathematical concepts.*

- *It is not modeling in the sense of a "model" being just a graph, equation, or function.*

- *It is not just starting with a real world situation and solving a math problem.*

- *It is not beginning with the mathematics and then moving to the real world.*

PROBLEM-BASED LEARNING FAQ

- *How often do teachers do problem-based learning?*

- *How long do problem based lessons take?*

- *Do teachers use problem-based lessons to introduce a topic or after you've already taught it?*

- *How is problem-based learning assessed?*

- *How much time does it take to create a problem-based lesson?*

The Four C's

O Communication

O Curiosity

- 3.NBT.2 - Fluently add and subtract within 1000 using strategies and algorithms.
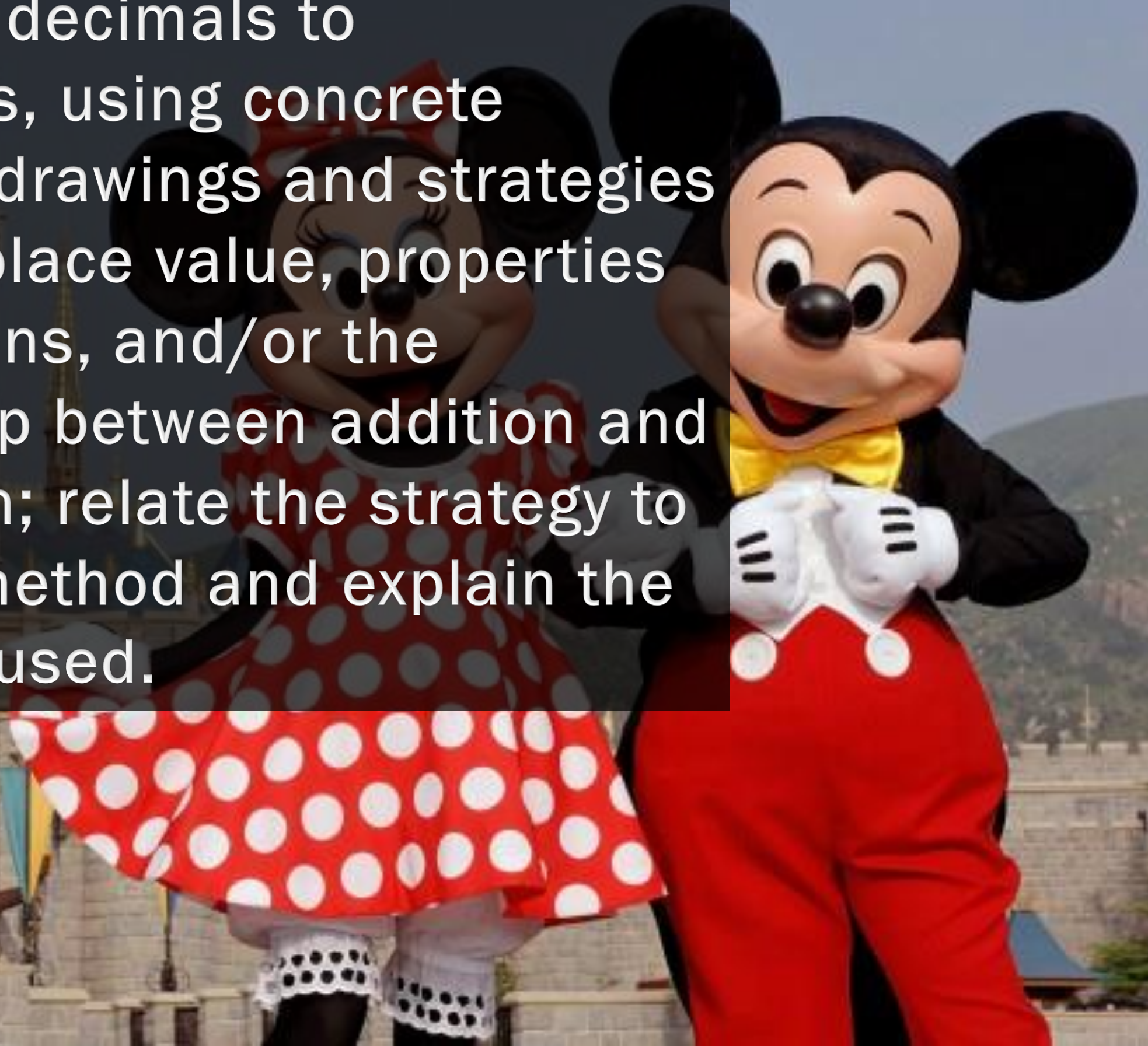- 3.NBT.3 - Multiply one-digit whole numbers by multiples of 10 in the range 10–90.
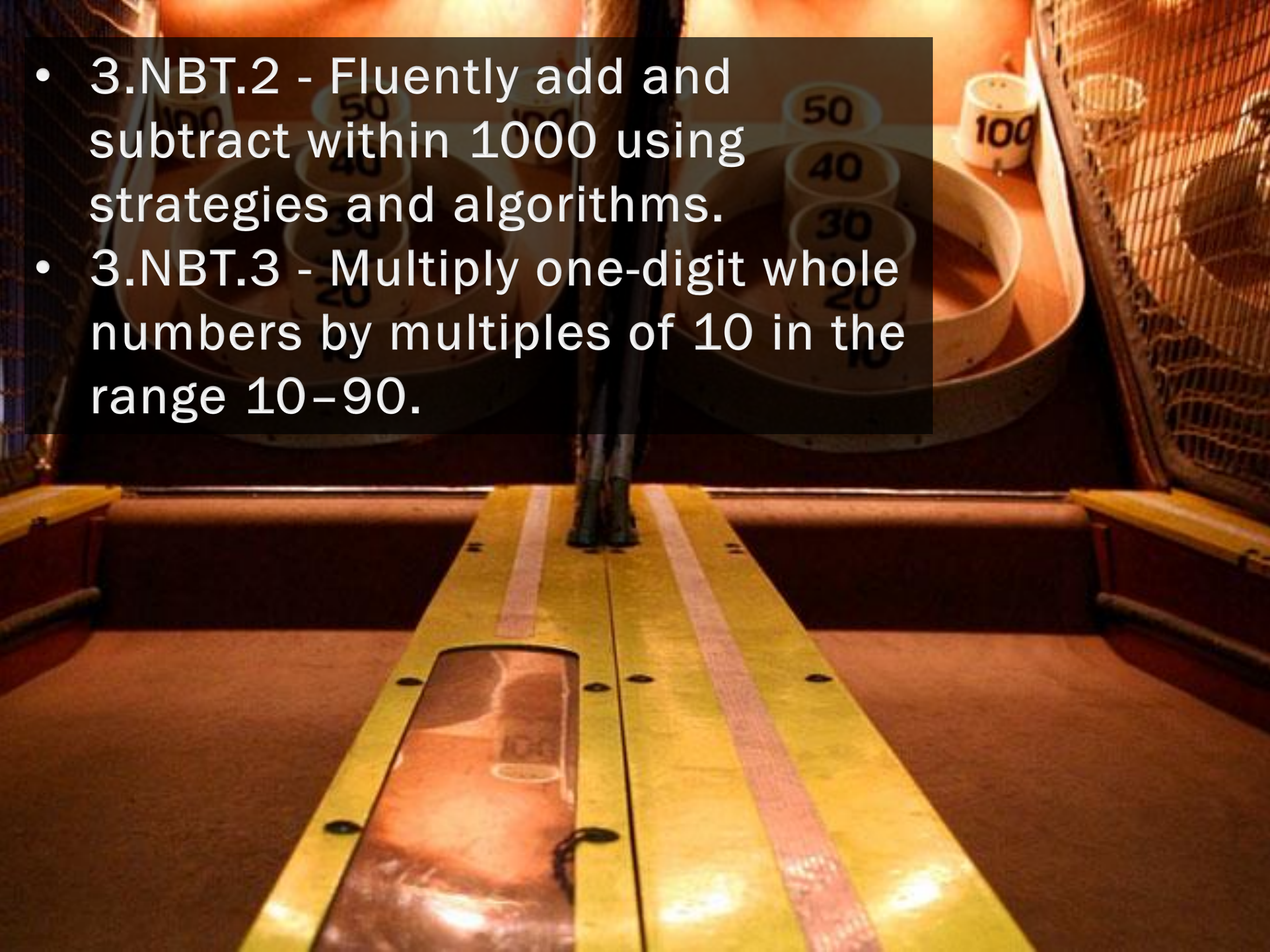
- 3.MD.1 - Tell and write time to the nearest minute and measure time intervals in minutes. Solve word problems involving addition and subtraction of time intervals in minutes.
- 4.MD.2 - Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money.
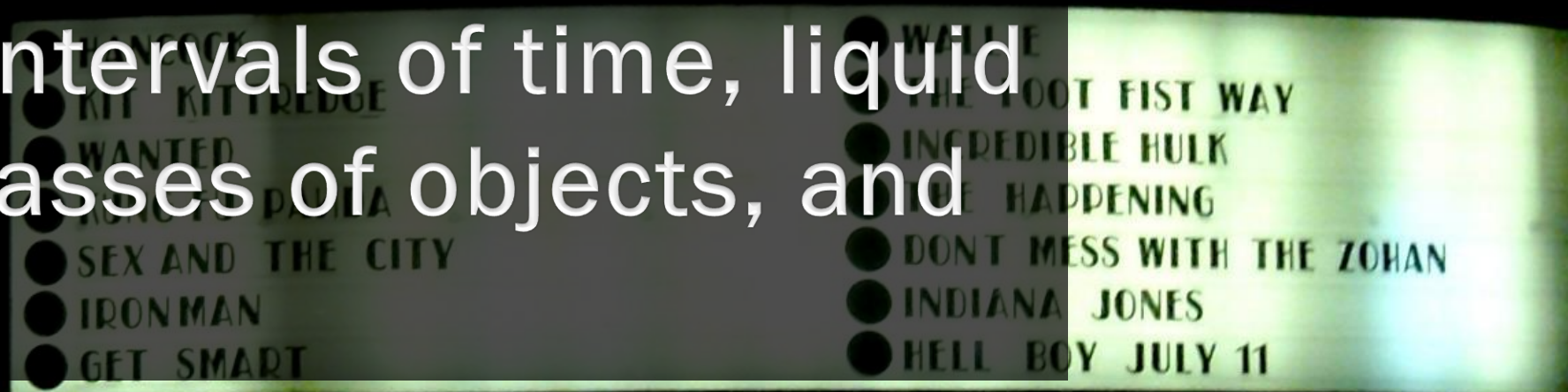
- 5.MD.5 - Relate volume to the operations of multiplication and addition and solve real world and mathematical problems involving volume.
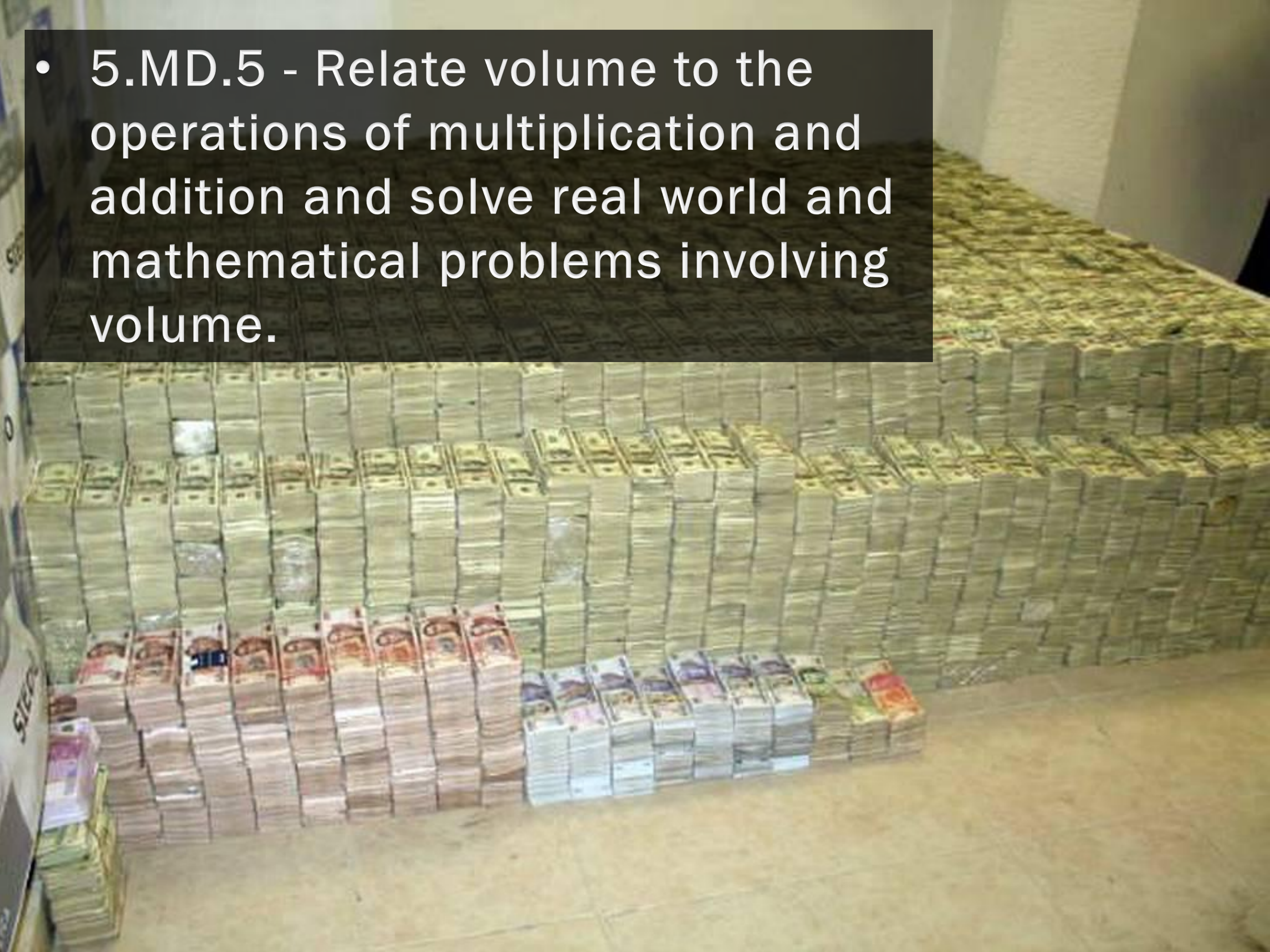
- 5.NBT.7 Add, subtract, multiply, and divide decimals to hundredths, using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; relate the strategy to a written method and explain the reasoning used.

The Four C's

O Communication

O Curiosity

O Critical Thinking

Problem Solving Framework

► Inspired by Geoff Krall's resources at emergentmath.com

Name: _____ Period: _____ Date: _____

What problem are you trying to figure out?	What guesses do you have?

What do you already know from the problem?	What do you need to know to solve the problem?

What should we title this lesson?

What is your conclusion? How did you reach that conclusion?

The Four C's

O Communication

O Curiosity
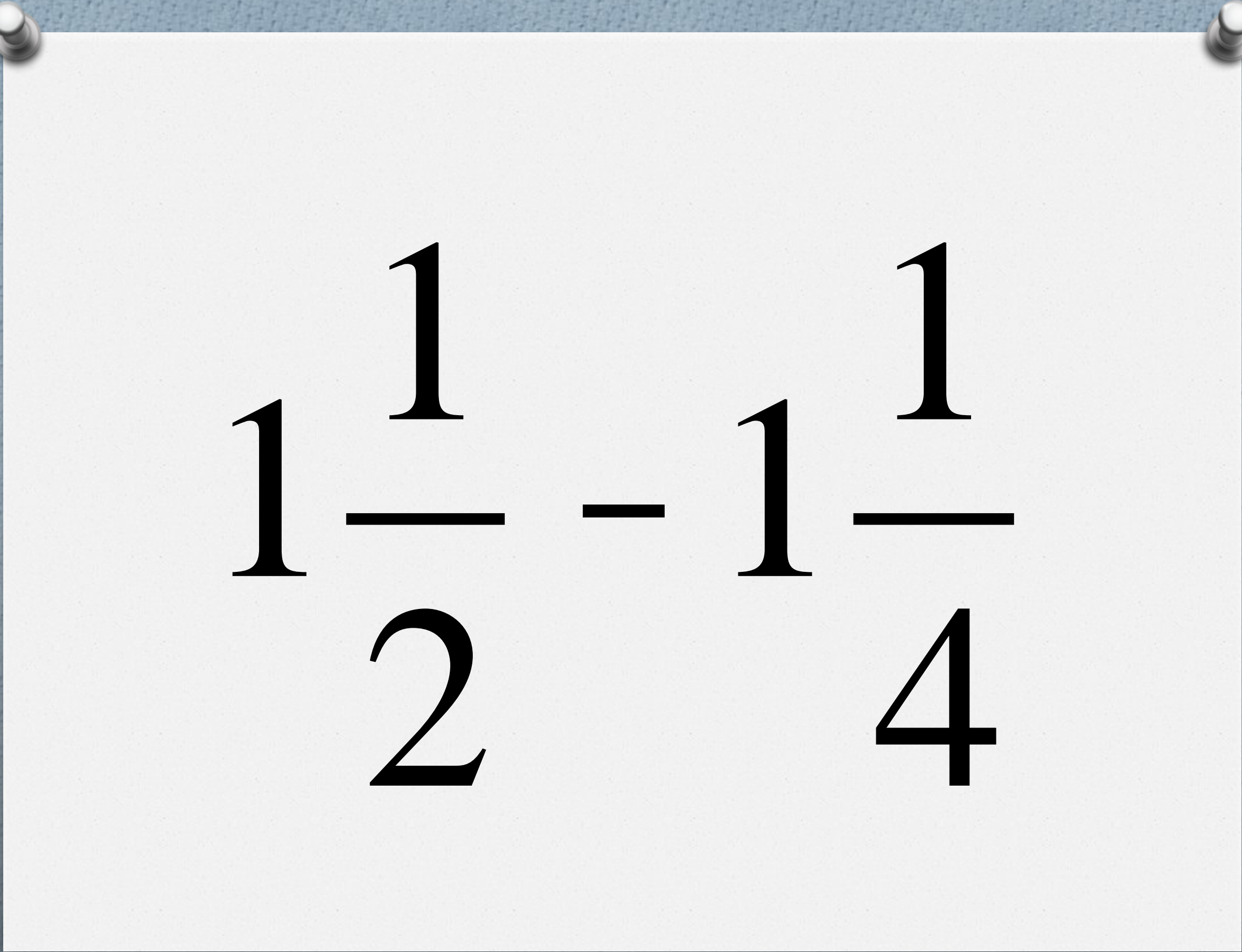
O Critical Thinking

O Content Knowledge

WHAT DOES IT LOOK LIKE...

- when students have procedural skill but not conceptual understanding or the ability to apply mathematics?

- when students struggle to process mathematics at a higher depth of knowledge?

How far apart are the exits on this freeway: Jct 90 and Jefferson Blvd?
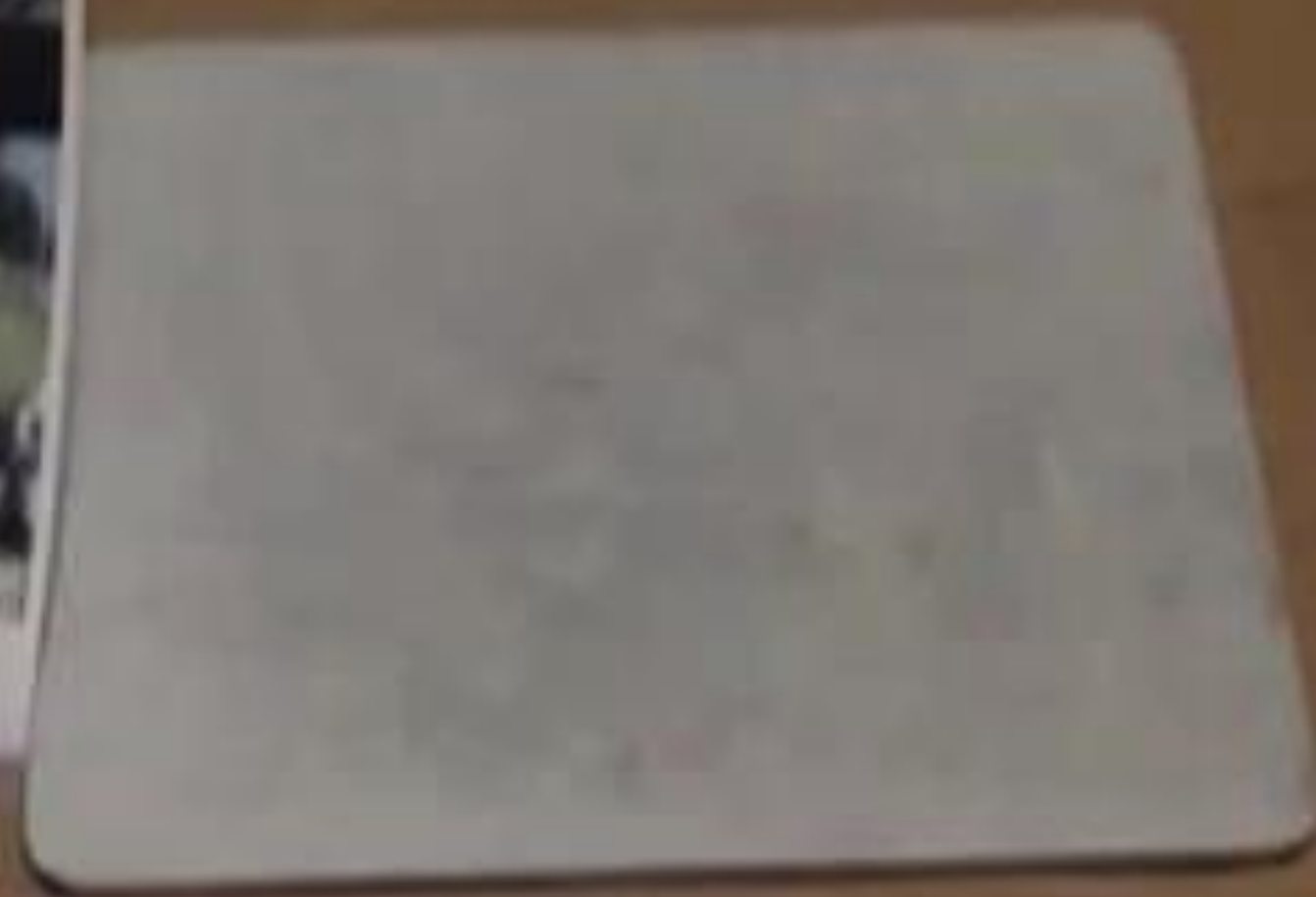
$$1\frac{1}{2} - 1\frac{1}{4}$$

$$1\frac{1}{2} - 1\frac{1}{4}$$

Questioning Scenarios

- The activity begins with teachers in groups of three taking the roles of teacher, student, or observer.

- The individuals playing the role of teacher and student each receive a slip of paper describing their scenario.

- The individual playing the role of observer waits to record all of the teacher's questions to the student.

- Once the activity begins, the teacher will talk to the student in the context of the scenario they read about on the slips of paper.

Which of these coins is worth the most money: nickel, quarter, or dime?

A quarter

Great. How did you figure that out?

The quarter is the biggest of those coins so it is worth the most.

Depth of Knowledge

- What?

Depth of Knowledge Examples

Perimeter

- DOK 1 – What is the perimeter of a rectangle with that measures 8 units by 4 units?

- DOK 2 – List the dimensions of a rectangle with a perimeter of 24 units.

- DOK 3 – Of all the rectangles with a perimeter of 24 units, which one has the most area?

Depth ... bles

What fraction is best represented by point P on this number line?

Fractions O...

P

IDENTIFY A FRACTION ON A NUMBER LINE

Directions: Label the point where 3/4 belongs on the number line. Be as exact as possible.

$$0 \qquad \frac{1}{3}$$

C $\quad \dfrac{3}{4}$

D $\quad \dfrac{7}{8}$
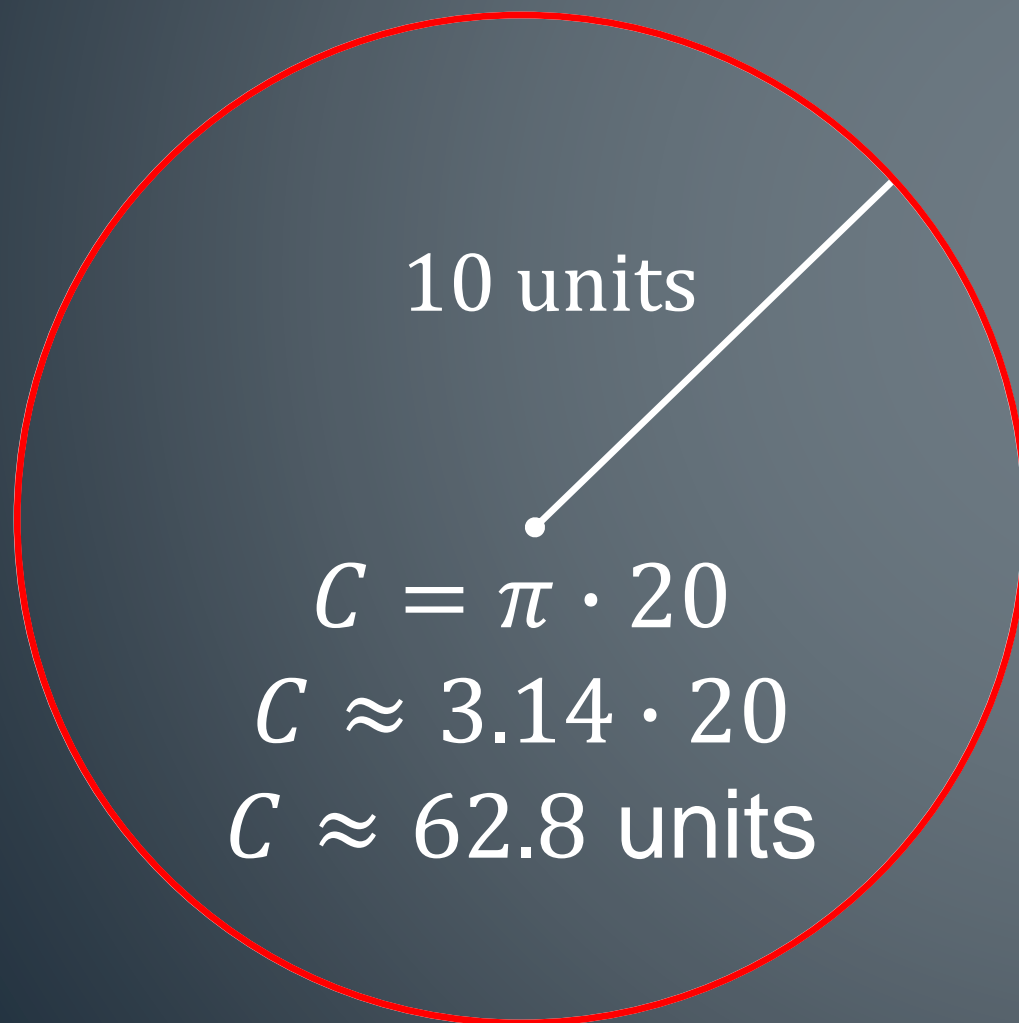
Depth of Knowledge

- What?

- How?

- Why?

Depth of Knowledge – Level One

What is the circle's circumference? $\pi \approx 3.14$

10 units

$C = \pi \cdot 20$
$C \approx 3.14 \cdot 20$
$C \approx 62.8$ units

$C = \pi d$ or $C = 2\pi r$

What is the circle's area? $\pi \approx 3.14$

10 units

$A = \pi \cdot 10^2$
$A \approx 3.14 \cdot 100$
$A \approx 314$ units^2

$A = \pi r^2$

70 This circular stage has a radius of 25 meters.

25 meters

Which equation could be used to find the area of the stage in square meters?

A $A = 25\pi$

B $A = 50\pi$

C $A = \pi \cdot 25^2$

D $A = \pi \cdot 50^2$

CSM02059

72 The top part of this hat is shaped like a cylinder with a diameter of 7 inches.
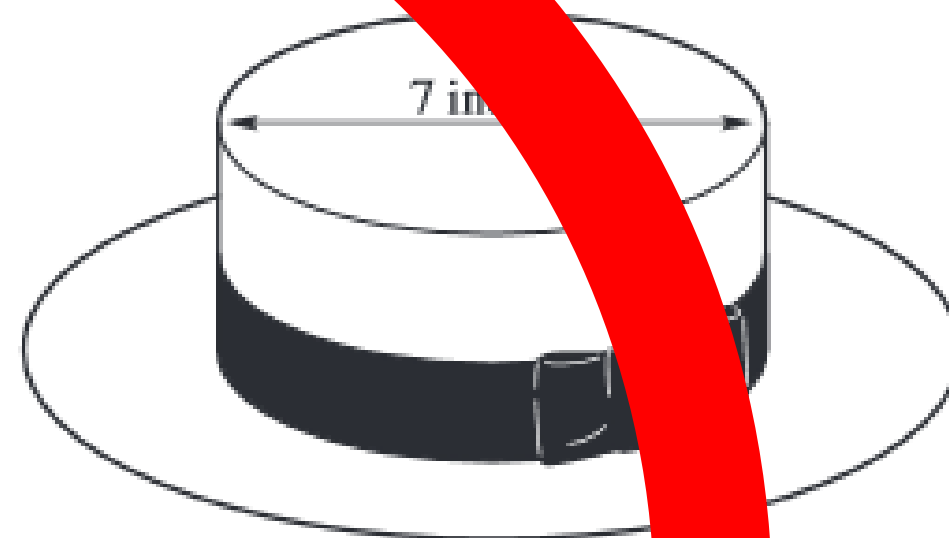
7 inches

Which measure is *closest* to the length of the band that goes around the outside of the hat?

A 10.1 inches

B 11.0 inches

C 22.0 inches

D 38.5 inches

CSM00268

Student Data Facts

- 396 seventh grade students were assessed
- 68.26% correctly answered the circumference question
- 78.59% correctly answered the area question

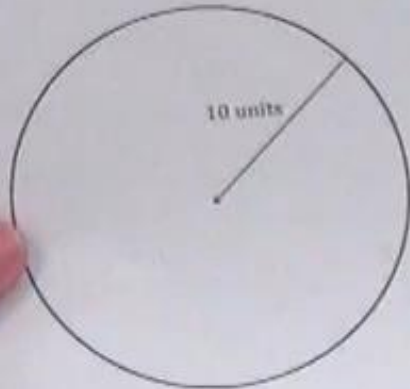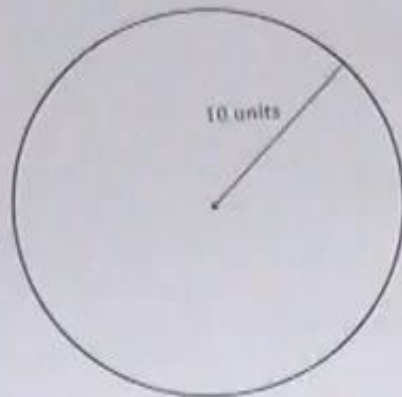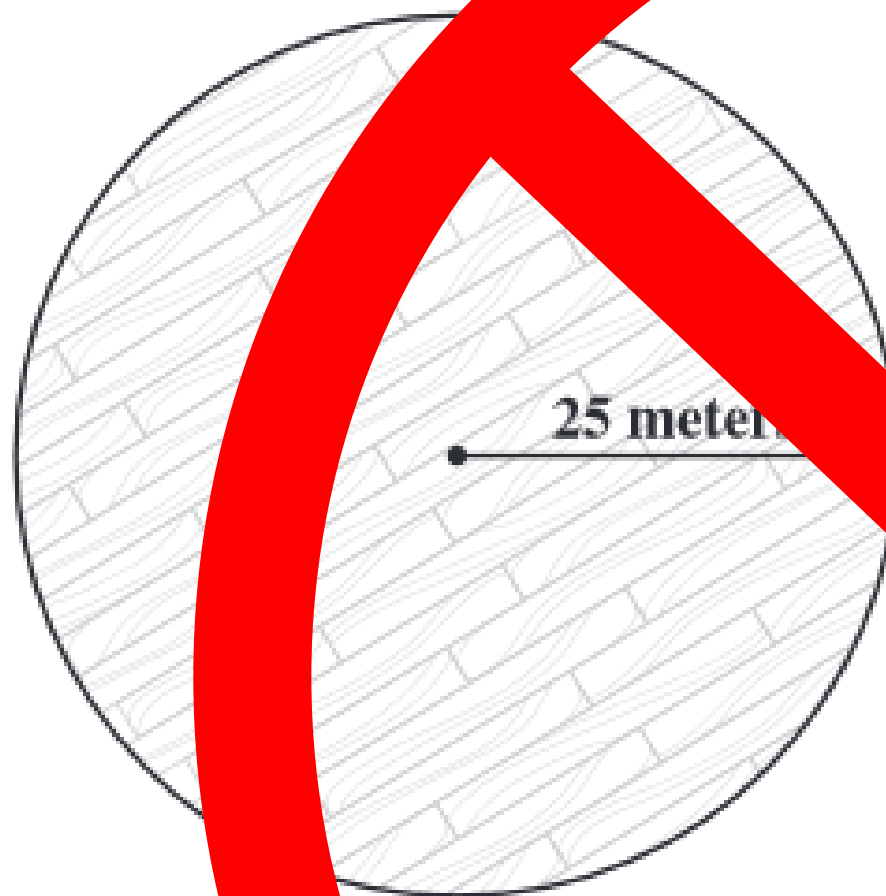| Claim	Content Category	Assessment Targets	DOK	Minimum # Scored Tasks		Minimum # Items per Item Type		Min/Max Number of Items
				CAT	PT/ECR	SR	CR	
		A. Analyze proportional relationships and use them to solve real-world and mathematical problems.	1,2					
		D. Solve real-life and mathematical			p(9)=1.0			
		E. Draw, construct, and describe geometrical figures and describe the relationship between them.	2,3					
		F. Solve real-life and mathematical problems involving angle measure, area, surface area, and volume.	1,2					
Supporting	Supporting Cluster	problems involving angle measure, area, surface area, and volume.	1,2					
		G. Use random sampling to draw inferences about a population.	1,2	0		2	1	5/8
		H. Draw informal comparative inferences about two populations.	1,2		p(2)=1.0			
		I. Investigate chance processes and develop, use, and evaluate probability models.	1,2					

70 This circular stage has a rad[...] [...]eters.

25 meter[...]

Which equat[...] [...]ould be used to find the area of the stage in [...]re meters?

A $A = 25\pi$

B $A = 50\pi$

C $A = \pi \cdot 25^2$

D $A = \pi \cdot 50^2$

72 The [...] f this hat is shaped like a cylinder with a dia[...] [...] 7 inches.

7 in[...]

Which measure is *closest* to [...] [...]ngth of the band that goes around the [...] [...]e of the hat?

[...] [...]0.1 inches

B   [...] inches

C   22[...] [...]s

D   38.5 in[...]

CSM00268

Depth of Knowledge – Level Two

Which circle is bigger? How do you know?

Circle A

Area = 36 units^2

Circle B

Circumference = 36 units

$$C = \pi \cdot 2 \cdot r$$

$$36 \approx 6.28 \cdot r$$

$$\frac{36}{6.28} \approx r$$

$$5.73 \; units \approx r$$

$$A = \pi \cdot r^2$$

$$A \approx 3.14 \cdot 5.73^2$$

$$A \approx 3.14 \cdot 32.83$$

$$A \approx 103.15 \; units^2$$

SBAC Constructed Response Rubric

- For full credit (2 points):
  - Student reaches the correct conclusion.

    AND

  - Student provides sufficient reasoning to support this conclusion.

- For partial credit (1 point):
  - Student reaches the correct conclusion but does not provide sufficient reasoning to support this conclusion.

    OR

  - Student does not reach the correct conclusion but provides reasoning to support this conclusion that contains a minor conceptual or computation error.

Which circle is bigger? How do you know?

Circle B
Circumference = 36 units

Circle A
Area = 36 units²

Video Facts

- Of the ten students interviewed:
  - Ten correctly answered both of the DOK 1 questions.
  - One earned two points on the DOK 2 question.
  - Six earned one point on the DOK 2 question.
  - Three earned zero points on the DOK 2 question.

Student Data Facts

- Of the 396 seventh grade students who were assessed, 12.12% earned two points on the DOK 2 question.

- 97.92% of the students who correctly answered the DOK 2 question also correctly answered both of the two DOK 1 questions.

- 10.61% of the students who correctly answered both of the two DOK 1 questions also correctly answered the DOK 2 question.

More Student Data Facts

- 28.28% of the students earned only one point.

- All of them earned one point by choosing Circle B and providing insufficient reasoning.

- 59.59% of the students earned no points.

Assessing Deeper Understanding

Make the smallest difference using the numbers 1 through 9 no more than one time each.
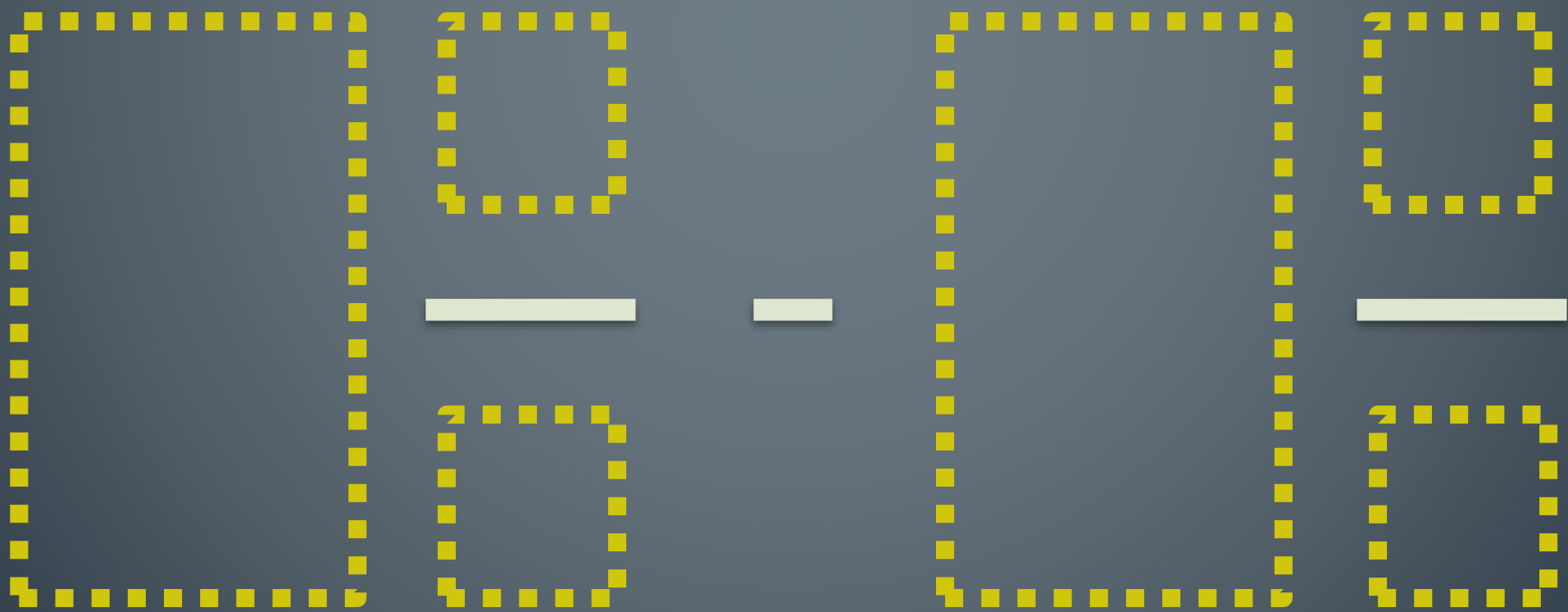
STUDENT WORK

First attempt: Points: ___/2 attempt   ___/2 explanation
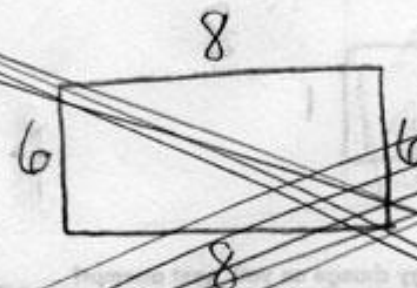
8

area: 48

6   6

8

What did you learn from this attempt? How will your strategy change on your next attempt?

This attempt doesn't equal 24.

Second attempt: Points: ___/2 attempt   ___/2 explanation
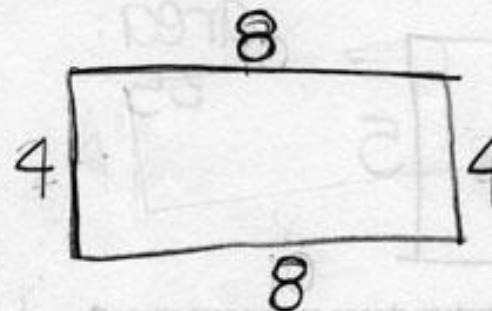
8

area: 32

4   4

8

What did you learn from this attempt? How will your strategy change on your next attempt?

The perimeter was 24, and the area was 32 but I think there's a bigger # strategy.

Third attempt: Points: ___/2 attempt   ___/2 explanation

10

area: 20

2   2
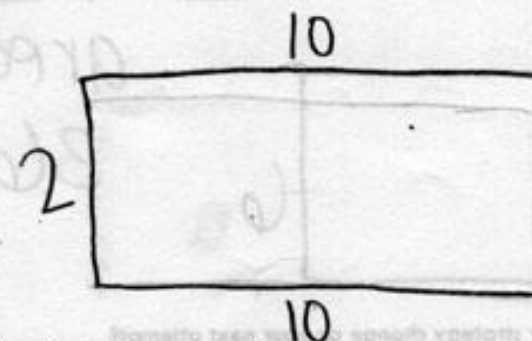
10

What did you learn from this attempt? How will your strategy change on your next attempt?

I learned that the perimeter is 24 but there's a bigger area strategy.

Open Middle Problems

- Open middle problems require a higher depth of knowledge than most problems that assess procedural and conceptual understanding.
- They often have a "closed beginning" meaning that they all start with the same initial problem
- They often have a "closed end" meaning that they all end with the same answer
- They have an "open middle" meaning that there are multiple ways to approach and ultimately solve the problem

www.openmiddle.com

Problem-Based Lesson Resources

- Problem-based lesson search engine:

  http://robertkaplinsky.com/prbl-search-engine/

- My lessons: http://www.robertkaplinsky.com/lessons

- Dan Meyer: http://threeacts.mrmeyer.com

- Andrew Stadel: http://tinyurl.com/mrstadel

- Geoff Krall: http://tinyurl.com/PrBLmaps

- Dan Meyer's TED talk: http://tinyurl.com/meyer-TED

Google™ Custom Search

How Many Sheets Do You Need To Break Out Of Prison?

Operations with rational numbers

Why Choose Us?

1 Math content expert

Robert graduated from University of California, Los Angeles (UCLA) with a Bachelors of Science in Mathematics. He has taught mathematics to students at the elementary, middle, and high school levels. As an instructor for UCLA, he also taught math

Lessons

All 2nd 3rd 4th 5th 6th 7th 8th Algebra Functions Geometry Modeling Numb & Quant Stats & Prob

How Much Is One Third Of A Cup Of Butter?

How Do Skytypers Write Messages?

Task Name	Concept / Skill	Standard 1	Standard 2	Standard 3	Standard 4	Sta
How Can We Water All Of The Grass?	Circles, Pythagorean Theorem, trigonometric ratios	7.G.4	8.G.7	G-SRT.8	G-MG.1	G-M
How Much Money IS That?!	Volume of rectangular prism	5.MD.3	5.MD.4	5.MD.5	5.MD.5b	5.M
How Much Money Should Dr. Evil Demand?	Exponential Growth	N-RN.2	A-SSE.1	A-SSE.3c	A-SSE.4	A-R
How Tall Is Mini-Me?	Scale and Dividing Decimals	5.NF.5	5.NF.5a	5.NF.5b	6.NS.3	
How Did They Make Ms. Pac-Man?	Transformations (Rotations, Reflections, and Translations)	8.G.1	8.G.2	8.G.3	8.G.4	G-S
Which Ticket Option Is The Best Deal?	Unit Rates and Ratios	6.RP.2	6.RP.3	6.RP.3a	6.RP.3b	
How Far Apart Are The Freeway Exits?	Fractions on a Number Line and Subtracting Fractions	3.NF.2	3.NF.2b	4.NF.2	4.NF.3a	4.N
Do We Have Enough Paint?	Area	3.MD.5	3.MD.6	3.MD.7		
How Many Stars Are There In The Universe?	Scientific Notation	8.EE.3	8.EE.4			
What Rides Can You Go On?	Inequalities and Measurement	2.MD.1	6.NS.7a	6.NS.7b		
Do You Have Enough Money?	Money	2.MD.8				
Which Bed Bath & Beyond Coupon Should You Use?	Percent Discount	7.RP.3				
Is Gas Cheaper With Cash Or Credit Card?	Percent Discount	7.RP.3				
Where's The Nearest Toys R Us?	Pythagorean Theorem (Distance in coordinate system)	8.G.8	G-SRT.8	G-GPE.7		
How Sharp Is The iPhone 5's Retina Display?	Pythagorean Theorem (Length of a side)	8.G.7	G-SRT.8	G-GPE.7		
When Should She Take Her Medicine?	Operations with Time Intervals	4.MD.2				
How Big Are Sunspots?	Converting Units, Proportions, and Scientific Notation	5.MD.1	7.RP.2	7.G.4	8.EE.4	G-M
What Michael's Coupon Should I Use?	Percent Discount	7.RP.3	A-CED.3			
Is It Cheaper To Pay Monthly or Annually?	Decimal Operations and/or Systems of Equations	5.NBT.7	8.EE.8c	A-CED.3	A-REI.11	F-E
How Big Is The 2010 Guatemalan Sinkhole?	Volume of Cylinder	5.MD.3	5.MD.4	5.MD.5	8.G.9	G-C
How Can You Win Every Prize At Chuck E. Cheese's?	Decomposing Numbers and/or Systems of Equations	2.NBT.7	3.NBT.2	3.NBT.3	8.EE.8c	A-C
How Many Royal Flushes Will You Get?	Probability	7.SP.5	7.SP.6	7.SP.7	S-MD.5	S-M
How Much Does The Paint On A Space Shuttle Weigh?	Surface Area	6.G.4	7.G.6	8.G.7	G-MG.1	G-M
How Did Motel 6 Go From $6 to $66?	Percent Increase and Compound Interest	7.RP.3	A-SSE.1b	F-BF.1	F-IF.8b	F-L
How Much Does The Aluminum Foil Prank Cost?	Surface Area and Unit Rates	6.G.4	6.RP.2	6.RP.3	7.G.6	
How Many Laps Is A 5k Race?	Perimeter	4.MD.3				
Which Toilet Uses Less Water?	Systems of Equations/Inequalities	8.EE.8c	A-CED.3	A-REI.11	F-BF.1	
How Did Someone Get A $103,000 Speeding Ticket In Finland?	Linear Equations	A-CED.2	F-BF.1	F-IF.4	F-IF.6	
Which Pizza Is A Better Deal?	Area or Circle, Square, and Unit Rates	3.MD.5	3.MD.6	3.MD.7	4.MD.3	6.R
How Big Is The World's Largest Deliverable Pizza?	Area of Square	3.MD.5	3.MD.6	3.MD.7	4.NBT.3	4.M
How Many Sheets Do You Need To Break Out Of Prison?	Integer Operations	5.NBT.6				
Do Hybrid Cars Pay For Themselves?	Systems of Equations or Rates	6.RP.2	6.RP.3	8.EE.8c	A-CED.3	F-E
How Many Hot Dogs Did They Eat?!	Linear and Quadratic Functions	8.F.3	8.F.4	F-BF.1	F-BF.2	F-IF
How Much Purple Ribbon Will You Need?	Perimeter & Circumference	3.MD.8	4.MD.3	7.G.4		
Are We There Yet?	Adding Times	3.MD.1	4.MD.2			
Which Chinese Food Coupon Should I Use?	Percent Discount	7.RP.3				
How Big Is The Vehicle That Uses Those Tires?	Ratio and Proportions	7.RP.2				
Where Would The Angry Birds Have Landed?	Create Equation From Quadratic Graph	A-CED.1	F-BF.1	F-IF.4	F-IF.7a	F-L
How Many Movies Can You See In One Day?	Adding Times	3.MD.1	4.MD.2			
Which Carrots Should You Buy?	Unit Rates	6.RP.1	6.RP.2	6.RP.3		
How Fast Can You Throw A Baseball?	Converting Units and Unit Rates	5.MD.1	6.RP.2			

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