



Focus on Mathematical Reasoning: Tools and Strategies for Instruction

**Professional Development for
International Programs**

Session 2

Tuesday 18 September, 2018

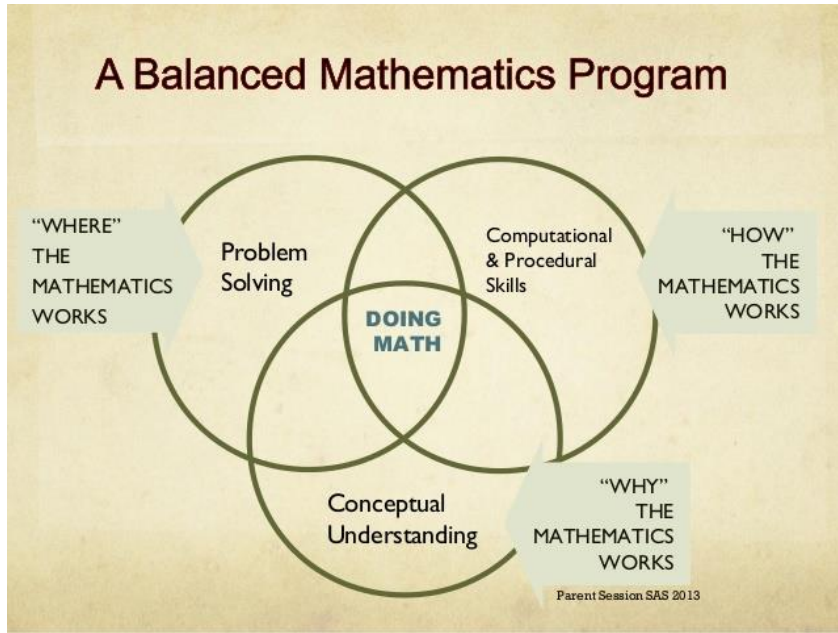
Math Involves...

- Memory
- Language
- Sequencing
- Spatial ordering
- Critical thinking
- Good problem-solving strategies
- Number sense
- Reasoning
- Making connections

In the Classroom, We Often...

- Introduce new concepts too rapidly
- Insufficiently support explanations and activities
- Provide insufficient practice
- Focus on facts versus concepts
- Limit access to manipulatives and
- Limit connection of skills to real-life situations

Students Need...



CONSISTENCY
IS 

Session Objectives



- Review expectations of the Mathematical Reasoning test
- Explore and use reading strategies to improve problem solving
- Explore thinking routines to teach the steps in mathematical reasoning
- Share resources and ideas

An Overview

Mathematical Reasoning

Overview

- One test with calculator allowed on most items – TI 30XS on screen
- Content
 - 45% - Quantitative Problem Solving (rational numbers and shapes and measurement)
 - 55% - Algebraic Problem Solving (graphs and functions & expressions and equations)
- Integration of math practices

Item Types

- Technology-enhanced items
 - Multiple choice
 - Drag-drop
 - Drop-down
 - Fill-in-the-blank



Math Practices

Overarching Habits of Mind
1. Make sense of problems and persevere in solving them.
6. Attend to precision.

Reasoning and Explaining
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.

Modeling and Using Tools
4. Model with mathematics.
5. Use tools strategically.

Seeing Structure and Generalizing
7. Look and make use of structure.
8. Look for and express regularity in repeated reasoning.

Workbook p. 2

Too Much to Teach – Too Little Time?



Start with the PLDs in the Classroom

Use PLDs to:

Tip 1: Assess student's current skill level

Tip 2: Determine when students are ready to test

Tip 3: Shape learning activities

Tip 4: Add perspective to lesson plans

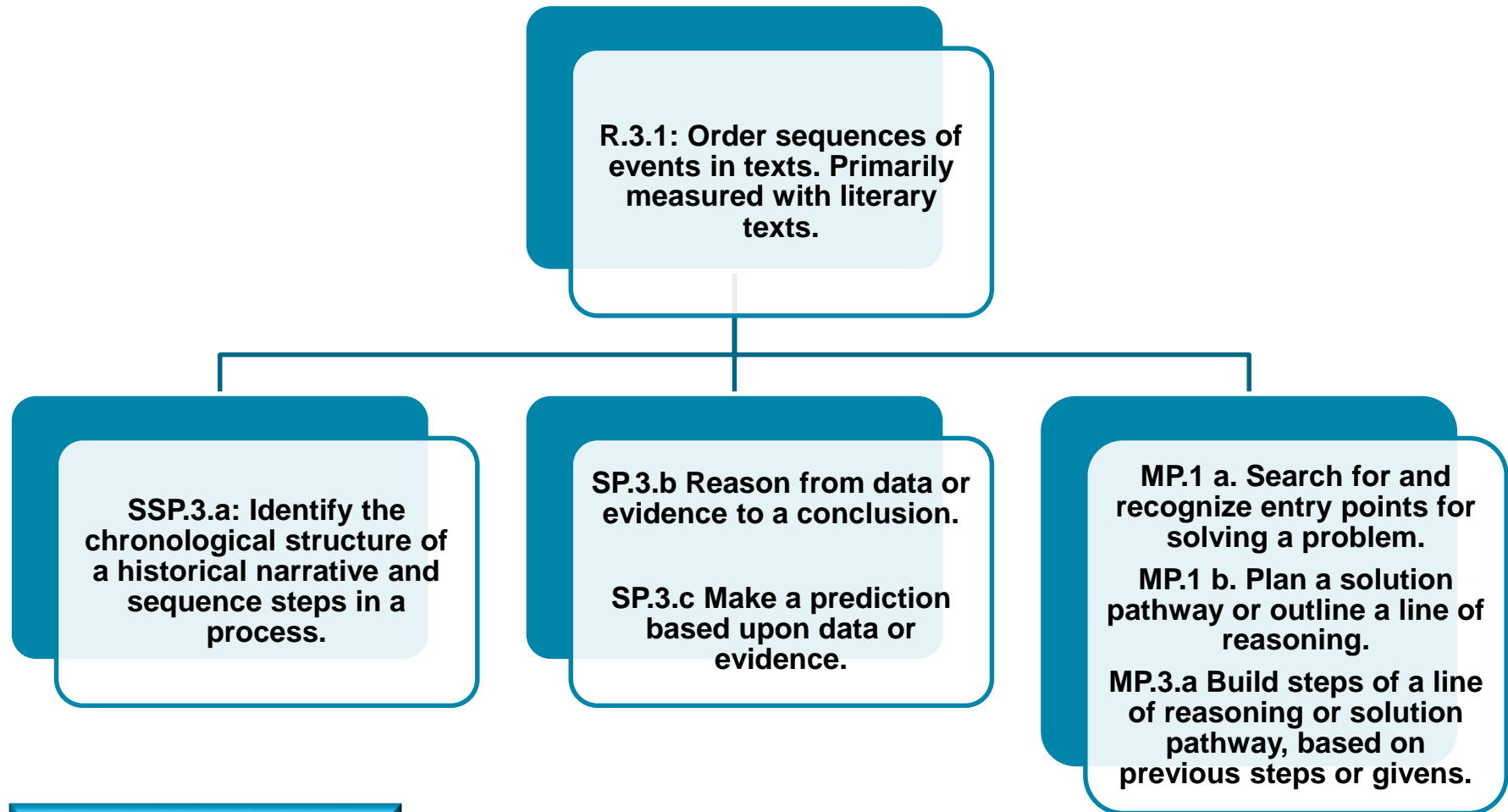
Then use High Impact Indicators to help plan instruction

- Important skills that are widely applicable
- May currently receive light coverage during GED® test preparation
- Lend themselves to straightforward instruction

High Impact Indicator for Math

Indicator	What to look for in student work. Students' work shows they have...
Q.4 Calculate dimensions, perimeter, circumference, and area of two-dimensional figures Q.5 Calculate dimensions, surface area, and volume of three-dimensional figures	<ul style="list-style-type: none">• identified the dimensions of a geometric figure from a diagram, then substituted the values for those dimensions into the appropriate formula for geometric measurement, then calculated the resulting numerical expression.• calculated the perimeter of polygons.• identified the shapes that comprise a composite figure.

Sequencing – It's Essential in Math!



Workbook p. 3

What Are the Foundational (“Must-Haves”) in Mathematical Reasoning?

“Must haves” in Math

- Consistency
- Fluency
- Well-developed number sense
- Skills in geometric measurement
- Skills in working in the coordinate plane
- Skills in interpreting graphics
- Skills in working with basic statistical concepts

Skills for the non-calculator section

- Order fractions and decimals, including on a number line (Q.1.a)
- Absolute value and distance between two rational numbers (Q.1.d)
- Addition, subtraction, multiplication, and division on rational numbers (Q.2.a)
- Computations and write numerical expressions with squares and square roots of positive, rational numbers (Q.2.b)
- Determine when a numerical expression is undefined (Q.2.d)

Sections of the Math Session

- Introduction
- Overview
- Non-calculator skills
- Number sense
- Graphical data displays
- Order of operations
- Percent change
- Exponents and roots
- Properties of 0
- Algebraic reasoning
- Surface area and volume
- Translating word problems
- Reading/reasoning in math
- Routines for problem-solving
- Purposeful questions
- GEDTS website tools

Building Number Sense

Use a Number Line

Students with Number Sense...

- Think and reason flexibly with numbers
- Use numbers to solve problems
- Spot unreasonable answers
- Understand how to put numbers together and take them apart
- Understand number relationships

Are numbers *just* numbers?

Type of Number	Quick Description
Counting Numbers	$\{1, 2, 3, \dots\}$
Whole Numbers	$\{0, 1, 2, 3, \dots\}$
Integers	$\{\dots, -3, -2, -1, 0, 1, 2, 3, \dots\}$
Rational Numbers	p/q – p and q are integers, q is not zero
Irrational Numbers	π – 3.14159265358979323856... cannot be written as a simple fraction $\sqrt{3}, \sqrt{99}$
Real Numbers	Rational and Irrational

Defining Numbers

Choose a Number Set:

☒ Counting ☒ Integers ☒ Rationals ☐ Real

zoom +

The number line displays the following values from left to right: -3.5, -2.5, -1.5, -0.5, 0.5, 1.5, 2.5, 3.5. Below these are the corresponding fractions: $-7/2$, -3 , $-5/2$, -2 , $-3/2$, -1 , $-1/2$, 0 , $1/2$, 1 , $3/2$, 2 , $5/2$, 3 , $7/2$. The region from 0 to 3.5 is highlighted in light purple.

Rational numbers are numbers that can be written as the ratio of two integers.

Example: $5/2$ (2.5), $-1/4$ (-.25), etc.


Open Instructions


<https://unctv.pbslearningmedia.org/resource/mgbh.math.ns.numline/building-a-number-line/#.WU1B-IWcHnM>

The Number Line

- Provides a model for basic operations for all rational numbers
- Is a spatial object
- Allows students to situate themselves spatially in mathematics
- Permits students to conceptualize mathematics

Just a Sample

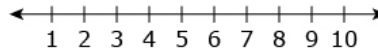
 Formula Sheet

 Calculator Reference

Julia wants to spend \$100 or less ordering shirts from an online company. The company charges a \$5 shipping fee for any order. The inequality $5 + 15n \leq 100$ represents the number of shirts, n , Julia can order from the online company. Graph all possible numbers of shirts that Julia can buy.

Click on the number line to plot the point(s).

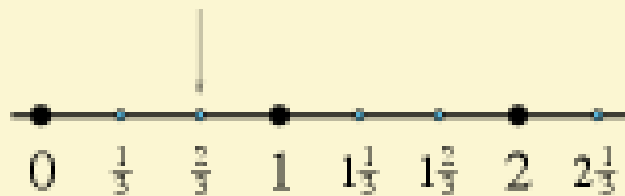
(NOTE: To remove a point, place the arrow over the point and click the left mouse button.)



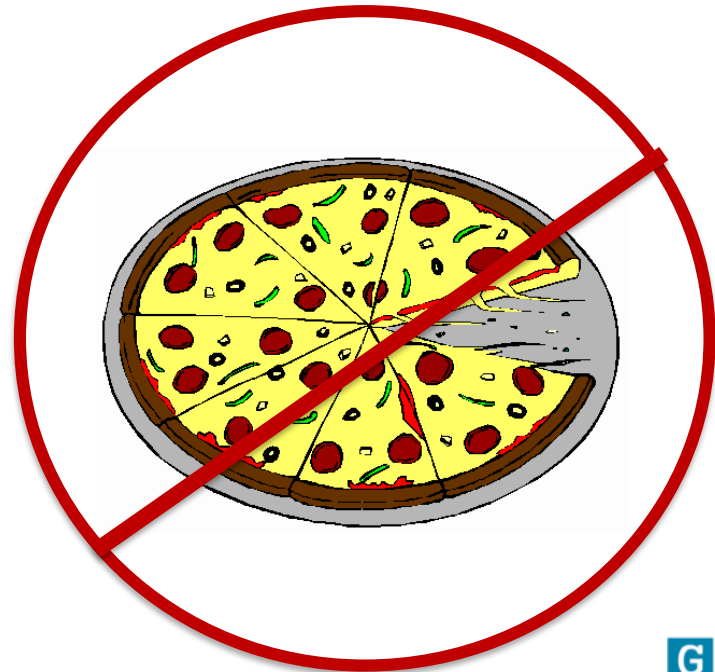
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Fractions

Students need to learn to *locate* a fraction on a number line.

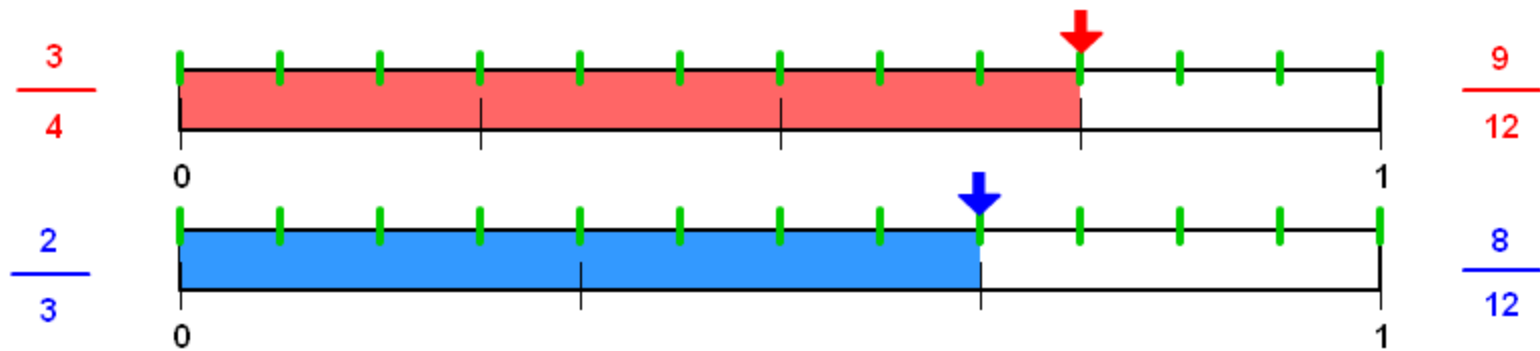


Use the number line so students understand that fractions are numbers and not just part of a pizza.



Can Students Use a Number Line?

The fractions $\frac{3}{4}$ and $\frac{2}{3}$ are pictured with number lines below:



Correct. The first fraction is greater than the second fraction.

$$\frac{3}{4} > \frac{2}{3}$$

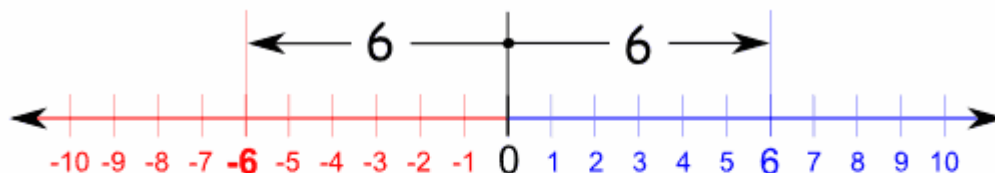
Absolute Value

Absolute Value means how far a number is from 0.

- Remove any negative sign and think of all numbers as positive
- Recognize symbol used to represent absolute value

$$|-5| = 5$$

$$|7| = 7$$



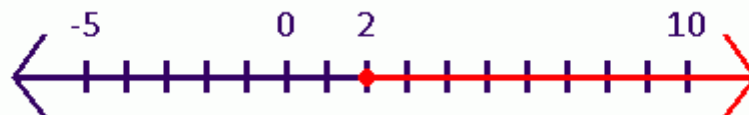
"6" is 6 away from zero,
and "-6" is **also** 6 away from zero.

So the absolute value of 6 is **6**,
and the absolute value of -6 is **also 6**

Inequalities

An inequality is a math statement that defines a range of values.

Jeffrey runs at least two miles every day.



On November 28, the temperature in North Pole, Alaska is expected to be greater than -4° and less than 9°



$$T < 6$$



<https://www.gedtestingservice.com/educators/exploring-the-2014-ged-test-webinar-archive>

Resources for Number Lines

Helping with Math - Number Line Generator

<http://www.helpingwithmath.com/printables/others/NumberLineGenerator01.htm>

Math Warehouse – Number Line Graph Maker

<http://www.mathwarehouse.com/number-lines/number-line-maker.php>

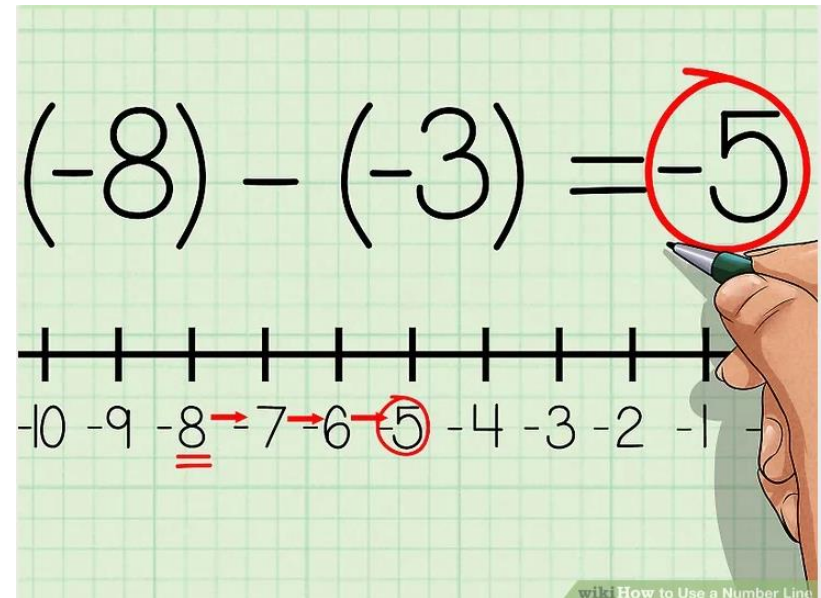
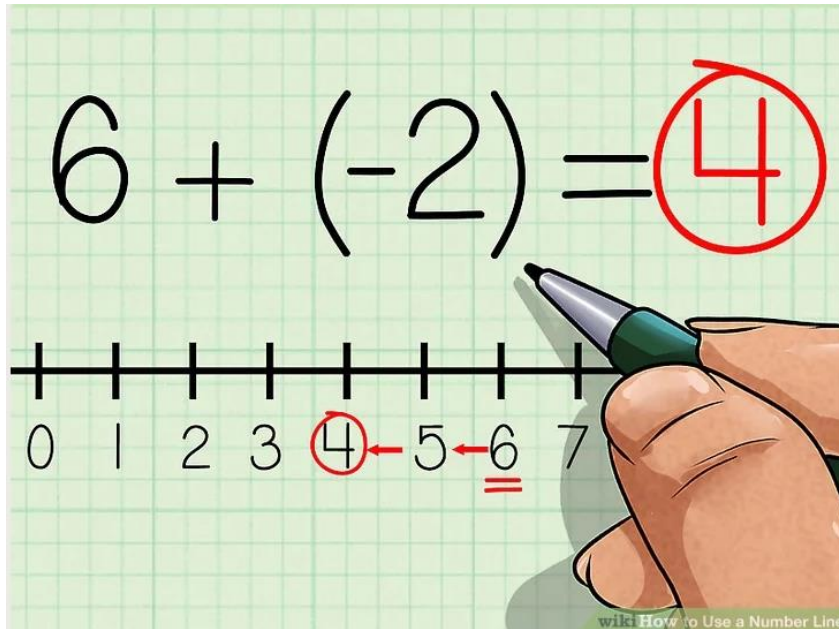
Math is Fun – Number Lines (Inequalities, Operations, etc.)

<http://www.mathsisfun.com/number-line.html>

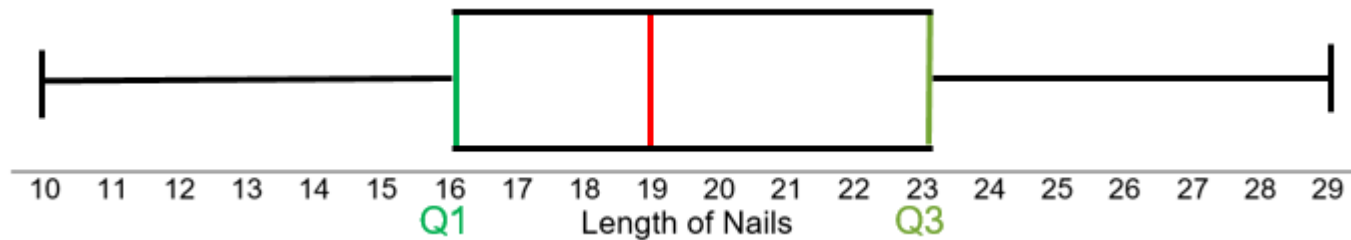
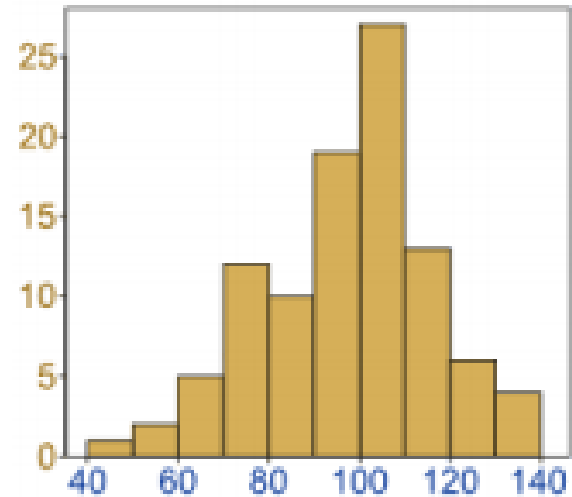
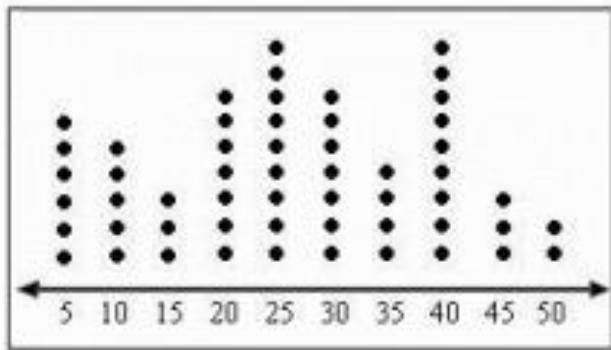
Annenberg Learner – Building the Number Line

http://www.learner.org/courses/learningmath/number/session1/part_c/index.html

Operations with Positive and Negative Integers



Data Displays



Essential Skills for Box Plots

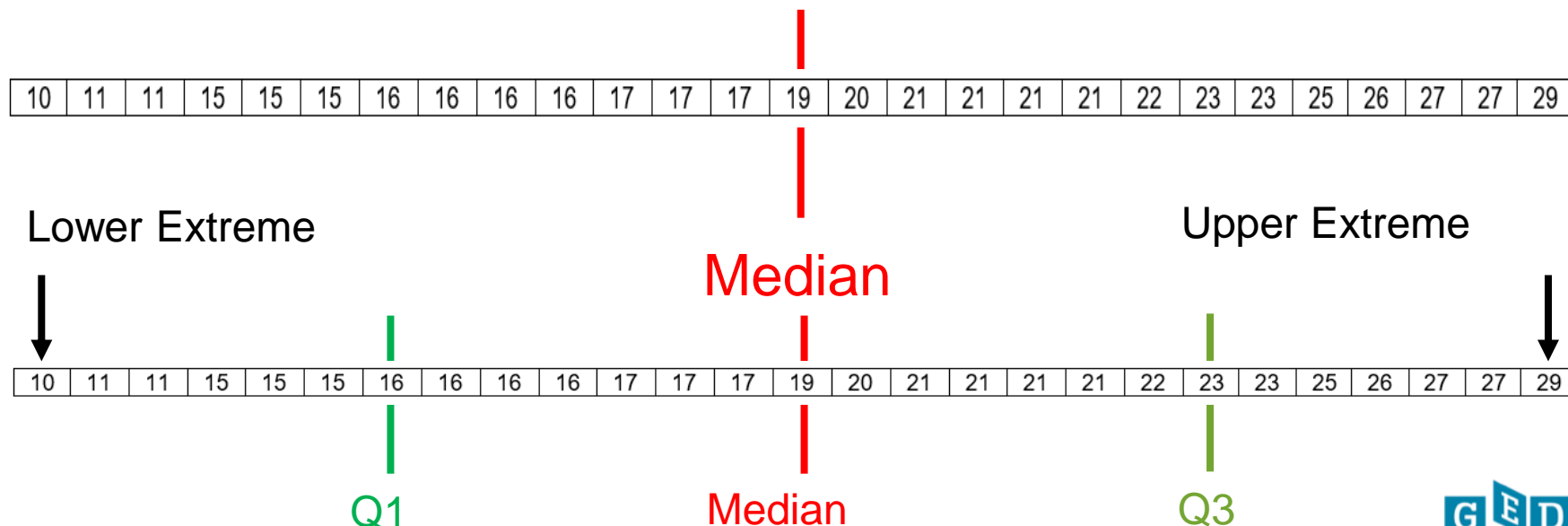
Arrange data in order

Find **median** for all data

Find median for lower half (“Q1”)

Find median for upper half (“Q3”)

Find the **range** of the extreme values



Order Matters

The Importance of Understanding the Order of Operations

Why Bother?

Here is your problem. $4 + 2 \times 3 =$

Is the answer 18 or 10?

- Avoid confusion in how problems are solved
- Set up rules of precedence or rank of operations
- Is critical to simplifying and solving different algebra problems

Answer the Why

The screenshot shows a Khan Academy video player interface. The top navigation bar is teal with 'Subjects', a search bar, the 'Khan Academy' logo, and a 'New user / Sign up' link. The left sidebar shows the course path: 'PRE-ALGEBRA > ARITHMETIC PROPERTIES' and 'Order of operations'. A list of video topics includes 'Intro to order of operations' (highlighted), 'Order of operations example', 'Worked example: Order of operations (PEMDAS)', and 'Practice: Order of operations'. Below this is a 'Next tutorial' link for 'Arithmetic properties'. The main video area has a black background with yellow and green handwritten text. It shows the expression $7 + 3 \times 5$ at the top. Below it, two calculations are shown side-by-side: on the left, $7 + 3 \times 5$ is followed by 10×5 and then 50; on the right, $7 + 3 \times 5$ is followed by $7 + 15$ and then 22. At the bottom of the video frame, white text reads 'because two people interpreted it a different way or another'. The video player controls at the bottom show a play button, a progress bar at 1:50 / 9:39, and icons for closed captions, settings, and full screen.

<https://www.khanacademy.org/math/pre-algebra/pre-algebra-arith-prop/pre-algebra-order-of-operations/v/introduction-to-order-of-operations>

Essential Understanding (aka “PEMDAS”)

1. Parentheses and Brackets

from the inside out

2. Exponents

of numbers or parentheses

3. Multiplication and Division

in the order they appear from left to right.

4. Addition and Subtraction

in the order they appear from left to right.

Get Rid of Misconceptions about Order of Operations

Misconception 1 - All multiplication should happen before division.

Incorrect	Correct
$12 \div 3 \times 4$	$12 \div 3 \times 4$
$12 \div 12$	4×4
1	16

P arenthesis
E xponents
M ultiply / D ivide
A dd + S ubtract

Misconception 2 – All addition comes before subtraction.

Incorrect	Correct
$4 + 10 - 5 + 8$	$4 + 10 - 5 + 8$
$14 - 13$	$14 - 5 + 8$
1	$9 + 8$
	17

Remember: M/D have the same precedence. Evaluate as they appear from left to right. Same with A/S.

Your Turn

What is the value of $6 \div 3 + 4 \times 2$?

So we do the division and multiplication before any addition or subtraction:

$$\begin{aligned} 6 \div 3 + 4 \times 2 \\ = 2 + 4 \times 2 \\ = 2 + 8 \\ = 10 \end{aligned}$$

Your Turn

What is the value of $6 \times 4 - 12 \div 3 - 8$?

We do 6×4 and $12 \div 3$ first, then the subtractions:

$$\begin{aligned} 6 \times 4 - 12 \div 3 - 8 \\ = 24 - 12 \div 3 - 8 \\ = 24 - 4 - 8 \\ = 20 - 8 \\ = 12 \end{aligned}$$

Your Turn

What is the value of $20 - (3 \times 2^3 - 5)$?

We start inside the **P**arentheses, and then use "**E**xponents" first:

$$20 - (3 \times 2^3 - 5) = 20 - (3 \times 8 - 5)$$

[Because 2^3 means $2 \times 2 \times 2 = 8$, **not** $2 \times 3 = 6$]

Next **M**ultiply:

$$20 - (3 \times 8 - 5) = 20 - (24 - 5)$$

Next **S**ubtract (still working inside the parentheses):

$$20 - (24 - 5) = 20 - 19$$

Now the **P**arentheses are completed, the last operation is **S**ubtract:

$$20 - 19 = 1$$

Your Turn

What is the value of $(12 \div 3 + 4) - (4^2 - 6 \times 2)$?

$$\begin{aligned} & (12/3 + 4) - (4^2 - 6 \times 2) \\ &= (4 + 4) - (4^2 - 6 \times 2) \\ &= 8 - (4^2 - 6 \times 2) \\ &= 8 - (16 - 6 \times 2) \\ &= 8 - (16 - 12) \\ &= 8 - 4 \\ &= 4 \end{aligned}$$

What's Your Sign?

In the equation below, replace each question mark with one of the four mathematical signs: +, -, \times , or \div . Each sign can be used only once. Fill in the blanks to solve the equation.
(Hint: the first sign is +.)

$$7 ? 5 ? 4 ? 7 ? 6 = 15$$

What is the first step that you need to take in order to solve the equation? Write your answer in the question box.

$$(7 + 5) \div 4 \times 7 - 6 = 15$$

Resources

Wyzant Resources – Lessons and Practice Problems

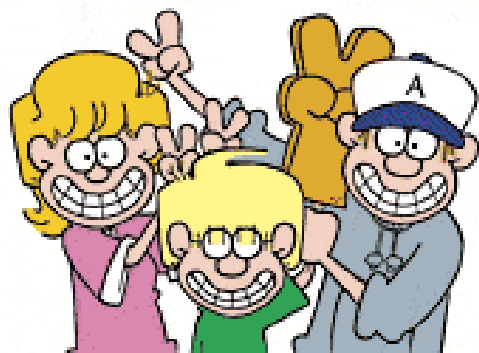
https://www.wyzant.com/resources/lessons/math/algebra/order_of_operations

Math is Fun –Sample problems

<http://www.mathsisfun.com/operation-order-pemdas.html>

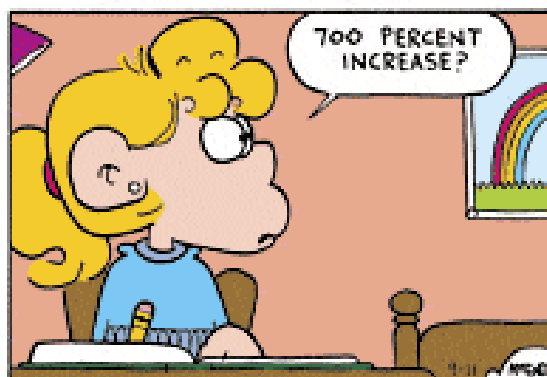
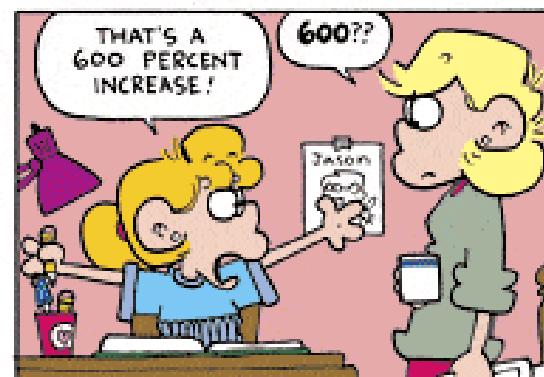
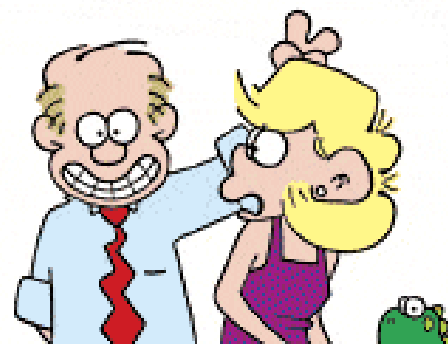
Percent Change

From Shopping to Identifying Trends



FoxTrot

by Bill Amend



Do your students know the vocabulary?

Ratio – a comparison between two different values

Percent of change – ratio of the amount of change to the original amount

Percent increase – how much original amount increases

Percent decrease – how much original amount decreases



$$\text{percent change} = \frac{\text{amount of change}}{\text{original amount}}$$

What do students need to know?

- An understanding of percent
- Part and whole
- Increase
- Decrease
- Original number
- Difference between percentage of and percent of change

Do they understand increase vs. decrease?

- If you buy a brand new car for \$15,999, drive it off the lot, and get into an accident, the car will be worth \$11,499. Does the car's value increase or decrease?
- The temperature at sunrise is 21 degrees Celsius . At noon, the temperature is 30 degrees Celsius. At sunset, it is 20 degrees Celsius. Has the temperature had an increase or decrease from sunrise to sunset?
- A scuba diver jumps off a dive boat into the water and descends 10m below sea level. He rises 3m to swim above a coral head, then swims back down 2.5m to the top of a submerged wreck. Has his depth shown an increase or decrease from his initial descent?

Percent of Increase

- Tips
- Sales Tax
- Increase in Population



To calculate percent of increase

$$\text{percent change} = \frac{\text{amount of increase}}{\text{original amount}}$$

Calculating a Percent of Increase

In 1981, there were 25 endangered and threatened species of reptiles in the U. S. In 2015, there 45 species. By what percent did the number of these reptile species change from 1981 to 2016?

$$80\% = \frac{20}{25}$$

Is the amount of change an increase or a decrease? (increase)

What is the amount of change from 1981 to 2015? ($45 - 25 = 20$)

What is the original amount? (25)

Divide the amount of change by the original amount ($20/25 = .8$)

Write the quotient as a percent ($.8 = 80\%$ increase)

Calculating a Percent of Increase

198,000 people attended a concert in 2007. The number of attendees increase by 12% from 2007 to 2017. How many attendees attended in 2017?

$$\begin{array}{|c|} \hline \text{Attendees} \\ \hline \text{in 2017} \\ \hline \end{array} = \begin{array}{|c|} \hline \text{Attendees} \\ \hline \text{in 2007} \\ \hline \end{array} + \begin{array}{|c|} \hline \text{Amount of} \\ \hline \text{increase} \\ \hline \end{array}$$

$$= 198,000 + 12 \times 198,000 \text{ (Substitute)}$$

$$= 198,000 + 0.12 \times 198,000 \text{ (write percent as a decimal)}$$

$$= 221,760 \text{ (Evaluate)}$$

Percent of Decrease

- Discounts
- Sales
- Reduction in Population



To calculate percent of decrease

$$\text{percent change} = \frac{\text{amount of decrease}}{\text{original amount}}$$

Calculating a Percent of Decrease

A stock was worth \$18.00 a share in 2000. In 2016, the same stock was worth \$7.60 a share. What was the percent of change?

$$58\% = \frac{10.40}{18.00}$$

Is the amount of change an increase or a decrease? (decrease)

What is the amount of change from 200 to 2016? (\$10.40)

What is the original amount? (\$18.00)

Divide the amount of change by the original amount (10.40/18)

Write the quotient as a percent (.57777 . . . = 58% decrease)

What's the Answer?

In June 2017, the price of stamps was \$0.49. Find the percent increase from 1978 to 2017.



Common Errors

- Using the wrong base when calculating change
- Not being able to differentiate between a quantity change and a percentage change
- Incorrectly changing a decimal to a percent
- Confusing "percentage **of**" situations with percent increase/decrease situations
- Not reading the situation (word problem) carefully

Resources for Percent Change

Art of Problem Solving: Percent Increase and Decrease Part 1

https://www.youtube.com/watch?v=vTPQV_M6tfl

Art of Problem Solving: Percent Increase and Decrease Part 1

<https://www.youtube.com/watch?v=TbUlfWJ9Ohw>

How to Find the Percent Change Increase: The Easy Way

<https://www.youtube.com/watch?v=YWOeN7hDD3E>

How To Find Percent Change Decrease: The Easy Way

<https://www.youtube.com/watch?v=fwhZ8ITiReY>

Exponents and Roots

A Continuing Problem

Students think an exponent is the same as multiplication.



I know $6^3 = 18$.
Right?

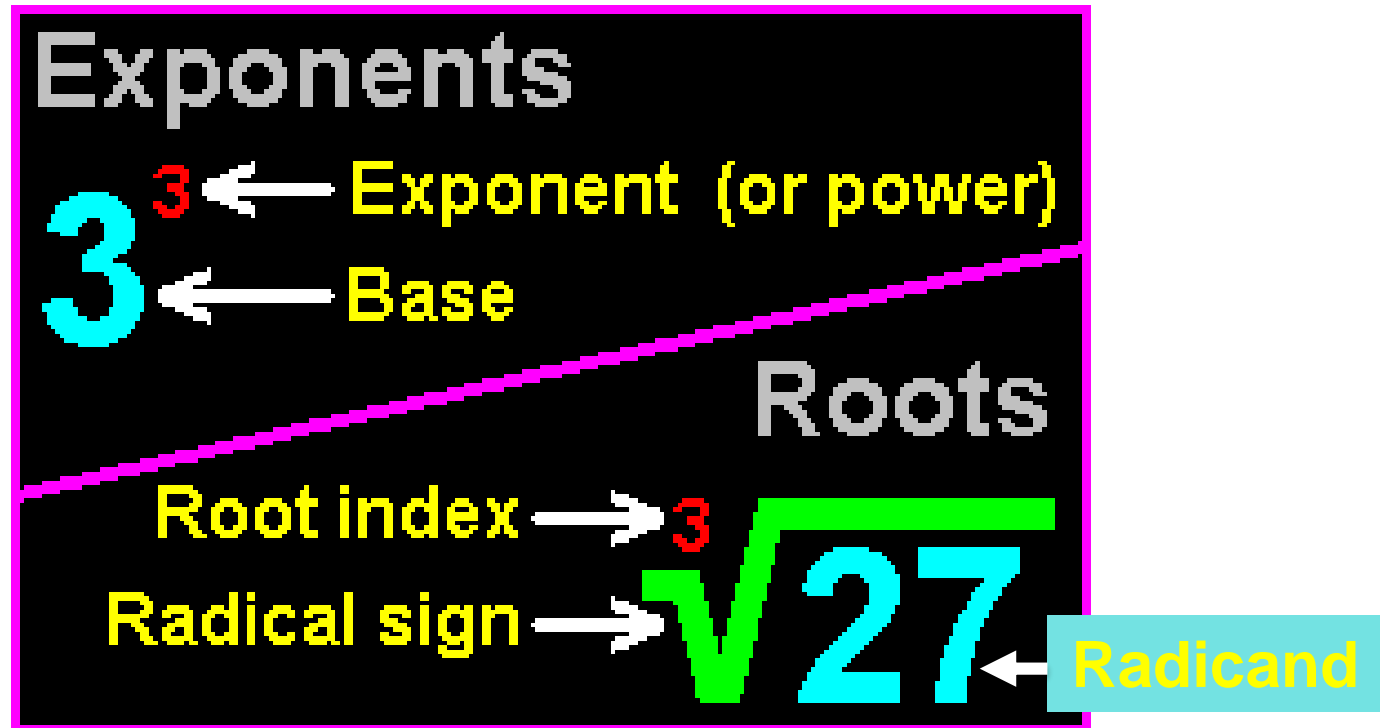
Multiplication =
Repeated Addition

$$6 \times 3 = 18$$
$$6 + 6 + 6 = 18$$

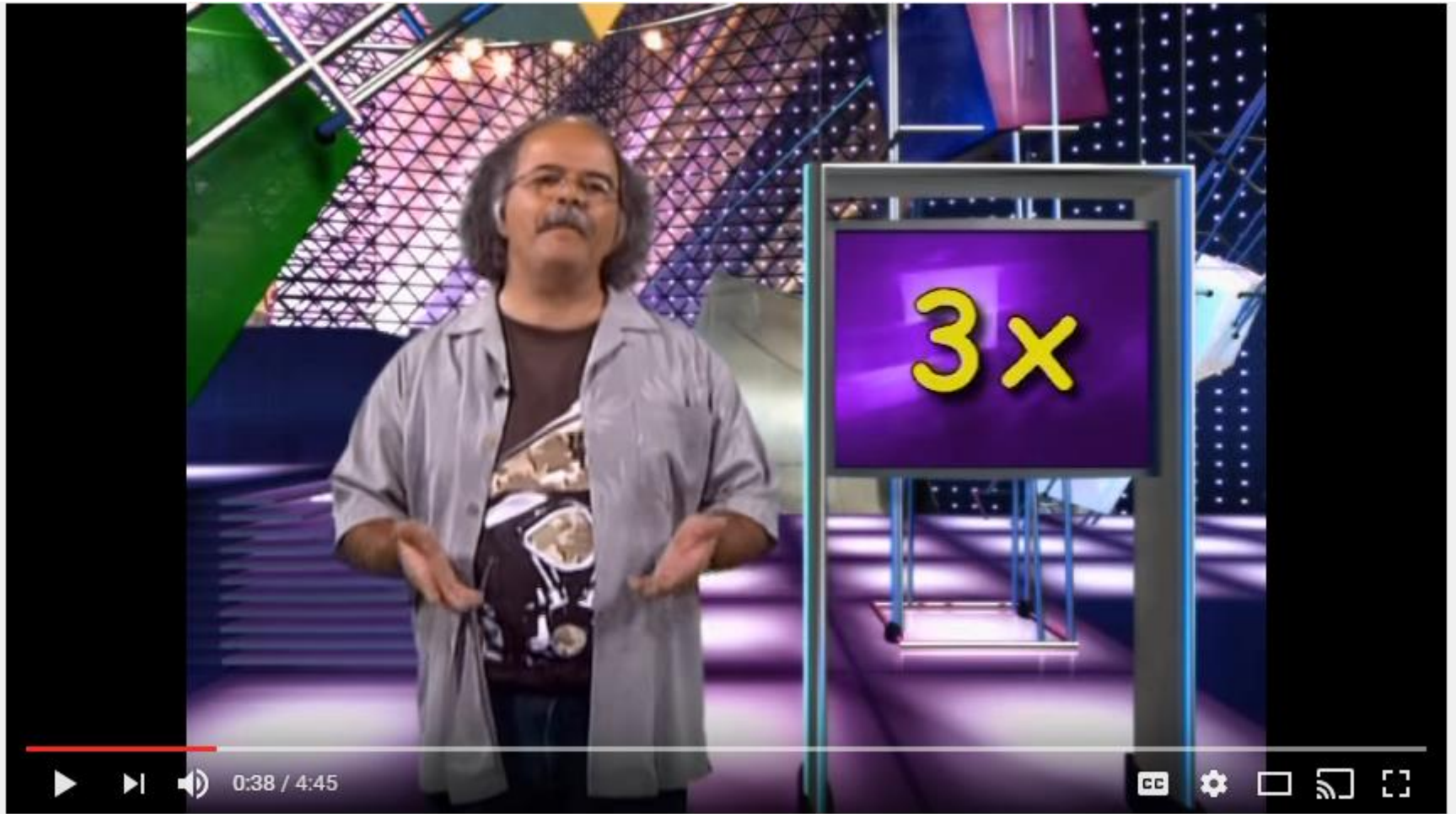
Exponents = Repeated
Multiplication

$$6^3 = 18$$
$$6 \times 6 \times 6 = 216$$

Do your students know the vocabulary?



Rules of Exponents Made Easier



The Math Dude – Law of Exponents - <https://www.youtube.com/watch?v=g4bKGsC2loY>

Rules of Exponents

	Rule	Example
1	$x^1 = x$	$5^1 = 5$
2	$x^0 = 1$	$5^0 = 1$
3	$x^{-1} = \frac{1}{x^1}$	$5^{-1} = \frac{1}{5}$
4	$(x^m)(x^n) = x^{m+n}$	$(x^2)(x^3) = x^{2+3} = x^5$
5	$\frac{x^m}{x^n} = x^{m-n}$	$\frac{x^3}{x^2} = x^{3-2} = x^1$
6	$(x^m)^n = x^{(m)(n)}$	$(x^3)^2 = x^{(3)(2)} = x^6$
7	$(xy)^n = x^n y^n$	$(xy)^3 = x^3 y^3$
8	$\left(\frac{x}{y}\right)^n = \frac{x^n}{y^n}$	$\left(\frac{x}{y}\right)^3 = \frac{x^3}{y^3}$
9	$x^{-n} = \frac{1}{x^n}$	$x^{-2} = \frac{1}{x^2}$

Squares and Square Roots of Positive Rational Numbers

Recommendations for Test-Takers

- Memorize the first 12 perfect squares (1, 4, 9, . . . , 144)
- Understand inverse relationship between pairs of squares and square roots ($12^2 = 144$ and $\sqrt{144} = 12$)
- Understand difference in squaring a negative number and the negative of a square number, i.e. $(-3)^2 = 9$ $-(-3)^2 = -9$
- Practice computing with squares and square roots that include fractions and decimals



Simplifying Radical Expressions

- $\sqrt{9}$
- Find the prime factors = $\sqrt{3 \cdot 3}$
- Bring any pairs outside the radical = 3

$$\begin{array}{l} \sqrt{9xy^2} \\ \sqrt{3 \cdot 3 \cdot x \cdot y \cdot y} \\ 3y\sqrt{x} \end{array}$$

Why do students need to know this?

Mathematical Reasoning - Candidate Name

Question 5 of 16

☒ Answer Explanation ☐ Symbol

Flag for Review

Type your answer in the box. You may use numbers, symbols, and/or text in your answer.

An expression is shown.

$$\sqrt{15} \cdot \sqrt{12}$$

Simplify the expression completely. Leave your answer in radical form.

(NOTE: Click the symbol selector when you need to enter the radical sign.)

Resources

Math is Fun – Explanations and sample questions

<https://www.mathsisfun.com/exponent.html>

The Math Dude – Law of Exponents -

<https://www.youtube.com/watch?v=g4bKGsC2IoY>

Khan Academy – Intro to Exponents

<https://www.khanacademy.org/math/pre-algebra/pre-algebra-exponents-radicals/pre-algebra-exponents/v/introduction-to-exponents>

Learning Upgrade – Exponent Rules

https://www.youtube.com/watch?v=VQsQj1Q_CMQ

The properties of 0

The Incredible Zero

- It is unique in representing nothingness.
- As a placeholder it gives our number system its power.
- It acquires different meaning based on its location. Think 30 versus 3,000.



The Origin of the Number Zero

<http://www.smithsonianmag.com/history/origin-number-zero-180953392/#qagAYijydW3RXhkh.99>

Properties of Zero

Property	Example
$a + 0 = a$	$4 + 0 = 4$
$a - 0 = a$	$4 - 0 = 4$
$a \times 0 = 0$	$6 \times 0 = 0$
$0 / a = 0$	$0/3 = 0$
$a / 0 = \text{undefined}$ (<u>dividing by zero is undefined</u>)	$7/0 = \text{undefined}$
$0^a = 0$ (a is positive)	$0^4 = 0$

<http://www.mathsisfun.com/numbers/zero.html>

The Problem with Zero

$$\frac{a}{0}$$

$$\frac{7}{0}$$

You can express a fraction with 0 in the denominator, but it has no meaning.

Division by zero is undefined. Mathematicians have never defined the meaning because there is no good definition.

“How many times can you throw nothing into no baskets?”

As many times as you want. It's just not a real number.

To learn more: <https://www.khanacademy.org/math/algebra/introduction-to-algebra/division-by-zero/v/why-dividing-by-zero-is-undefined>

Resources

Math is Fun – Properties of Zero

<http://www.mathsisfun.com/numbers/zero.html>

Math is Fun – Dividing by Zero

<https://www.mathsisfun.com/numbers/dividing-by-zero.html>

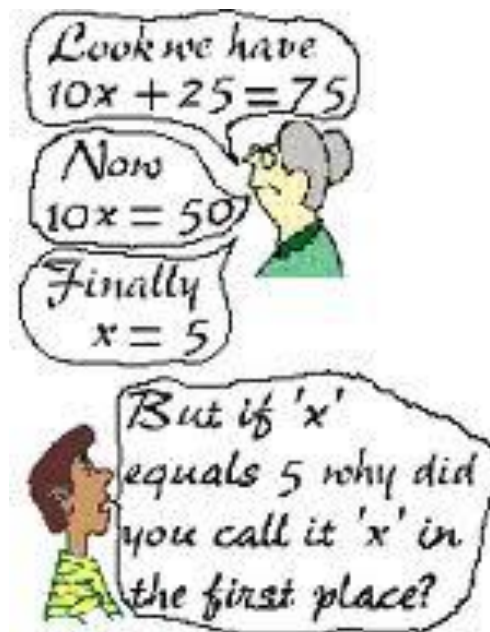
Khan Academy – Why Dividing by Zero is Undefined

<https://www.khanacademy.org/math/algebra/introduction-to-algebra/division-by-zero/v/why-dividing-by-zero-is-undefined>

GETTING DOWN TO BASICS WITH ALGEBRAIC REASONING

Remember . . .

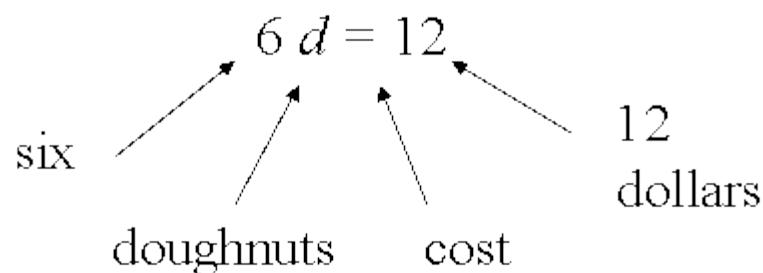
- Arithmetic is doing something to numbers to get an answer.
- Algebra is exploring the relationships between numbers.



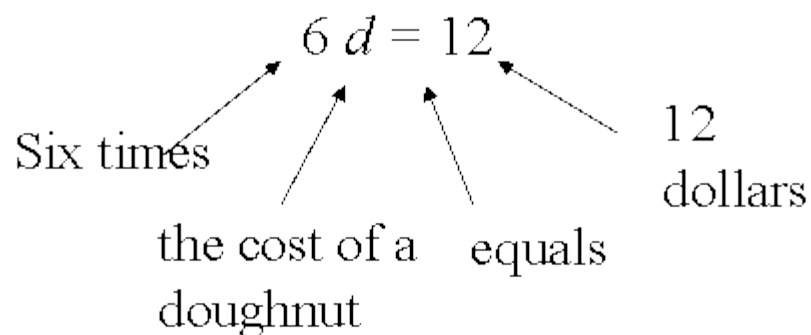
Variable

Some students believe that letters represent particular objects or abbreviated words

Wrong Interpretation



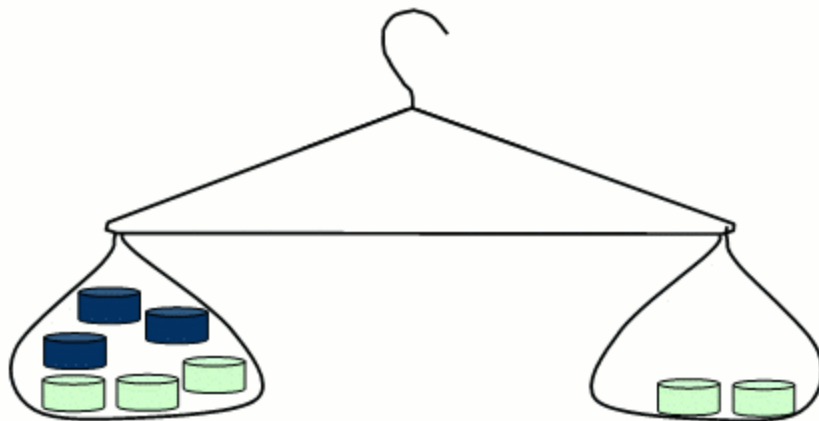
Correct Interpretation



Confusion About the Equal Sign

The equal sign stands for balance or equality.

The concept of balance can be used to reinforce the idea of equality – both sides of the number sentence need to be the same, the equation needs to balance.



Symbolic Notation

A Few Examples

Sign	Arithmetic	Algebra
= (equal)	. . . And the answer is	Equivalence between two quantities
+	Addition operation	Positive number
-	Subtraction operation	Negative number

Which Is Larger?

2^3 or 3^2

3^4 or 4^3

6^2 or 2^6

8^9 or 9^8



Use Multiple Representations

- Start with the concrete
- Represent problems using symbols, expressions, and equations, tables, and graphs
- Model real-world situations
- Complete problems different ways (flexibility in problem solving)

Equation	Tile Model	Written Description	Mathematical Procedure
$3x + 4 = -2$		<ol style="list-style-type: none"> 1. Given 2. Add 4 negatives to each side 3. Collect Like terms 4. Divide each side into three equal groups 5. Simplify 6. Check 	$ \begin{array}{rcl} 3x + 4 & = & -2 \\ -4 & = & -4 \\ \hline 3x & = & -6 \\ \div 3 & & \div 3 \\ \hline x & = & -2 \end{array} $

Would you teach multiplication . . .

This Way?

3,452

x 267

This Way?

3,452 x 267 =

Use Vertical Multiplication of Polynomials

$$(3g - 3)(2g^2 + 4g - 4)$$

becomes

$$\begin{array}{r}
 (2g^2 + 4g - 4) \\
 \times \quad (3g - 3) \\
 \hline
 -6g^2 - 12g + 12 \\
 6g^3 + 12g^2 - 12g \\
 \hline
 6g^3 + 6g^2 - 24g + 12
 \end{array}$$

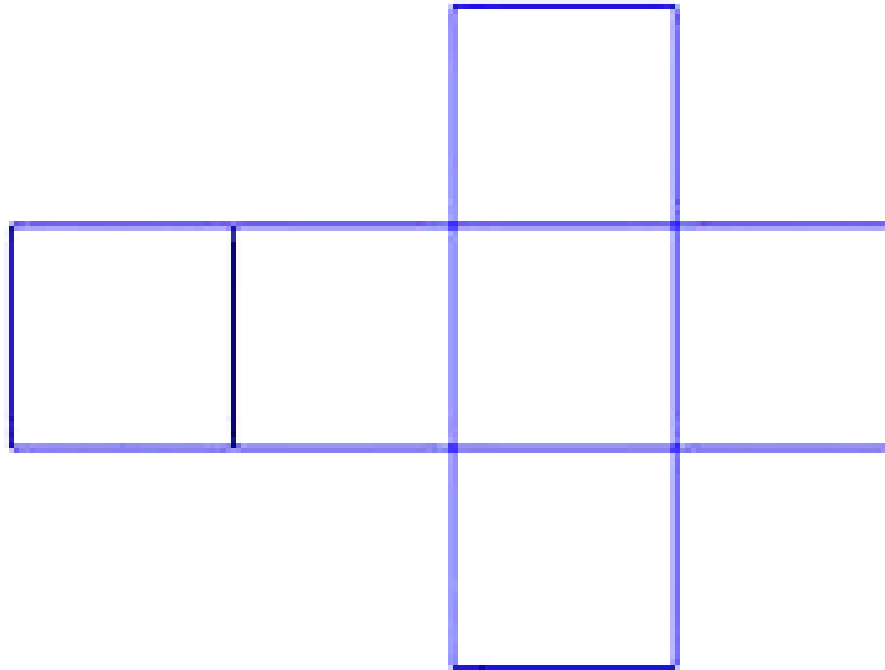
GETTING A GRIP ON SURFACE AREA AND VOLUME

Formulas

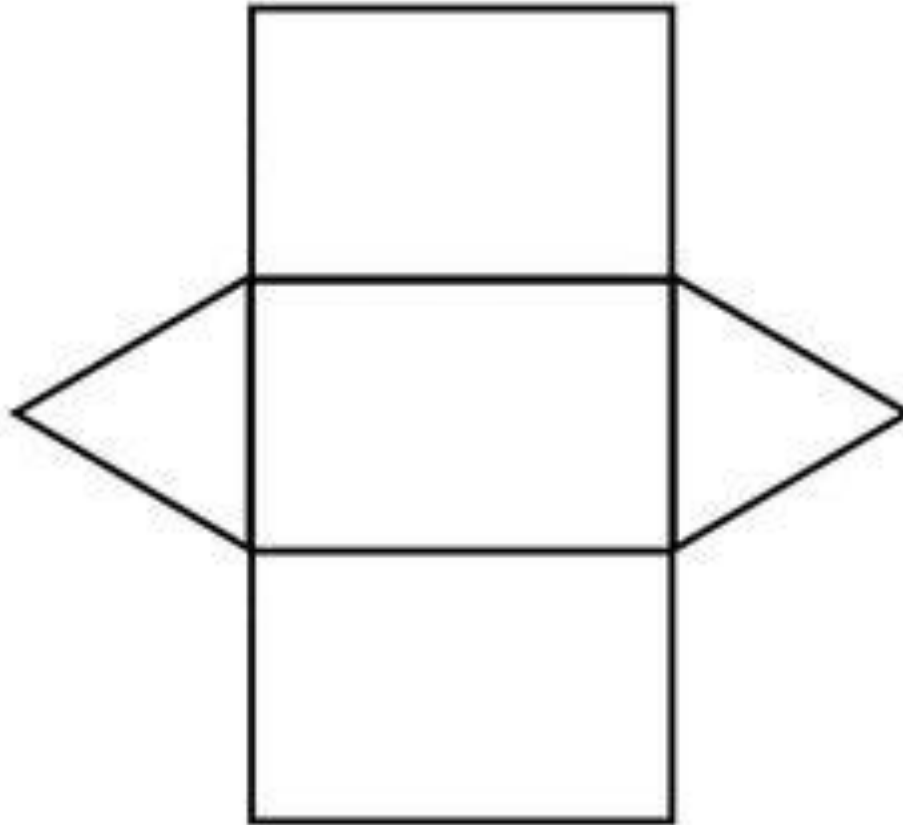
Figure	SA Formula	V Formula
Rectangular prism	$SA = ph + 2B$	$V = Bh$
Right prism	$SA = ph + 2B$	$V = Bh$
Cylinder	$SA = 2\pi rh + 2\pi r^2$	$V = \pi r^2 h$
Pyramid	$SA = \frac{1}{2}ps + B$	$V = \frac{1}{3}Bh$
Cone	$SA = \pi rs + \pi r^2$	$V = \frac{1}{3}\pi r^2 h$
Sphere	$SA = 4\pi r^2$	$V = \frac{4}{3}\pi r^3$

p = perimeter of base with area B ; $\pi = 3.14$

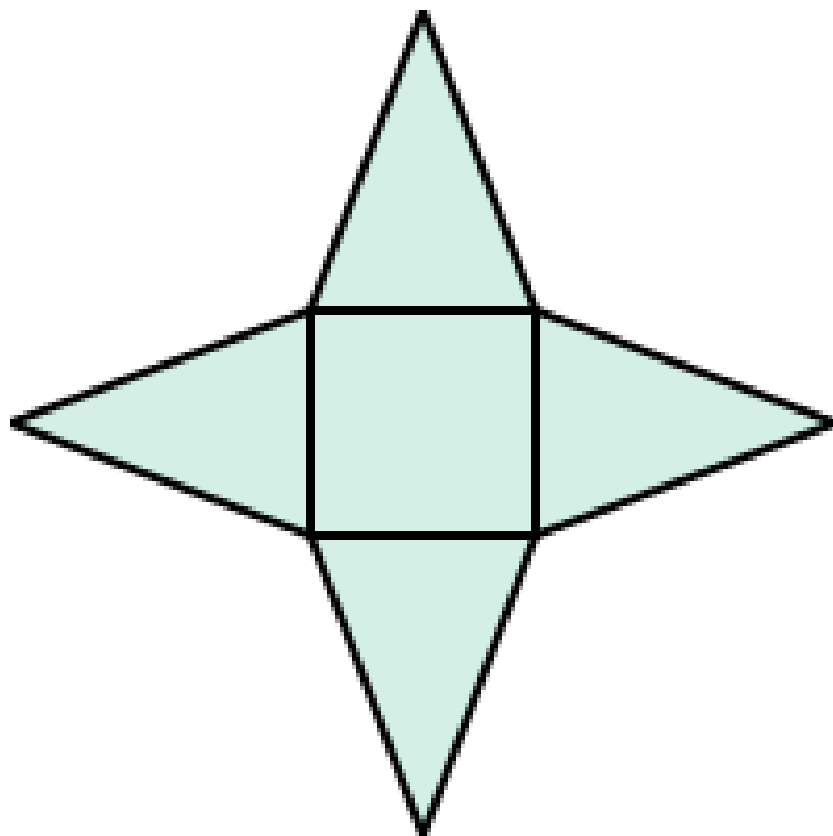
Quick Draw



Quick Draw



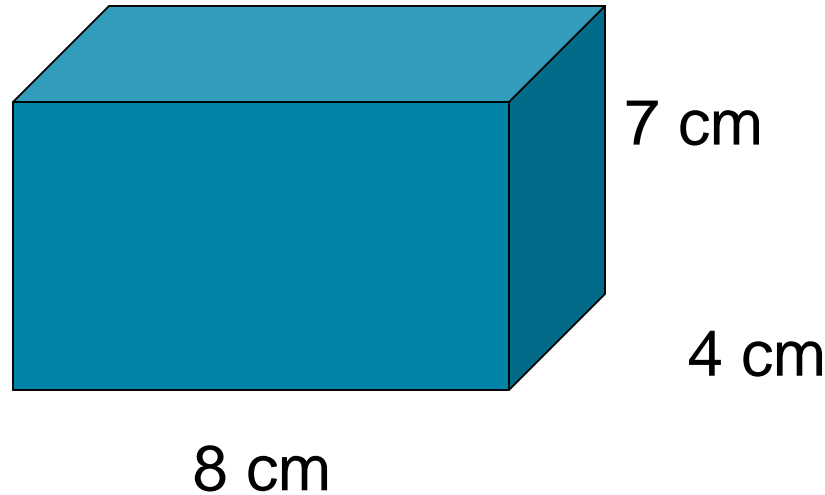
Quick Draw



Two Ways to Do It

Surface area can be computed by using the formula or by finding the area of each surface and adding them up!

Example:



Surface Area

Top/bottom $2(8)(4) = 64$

Left/right $2(4)(7) = 56$

Front/back $2(8)(7) = 112$

Add them up!

$SA = 232 \text{ cm}^2$

$$V = lwh$$

$$V = 8(4)(7)$$

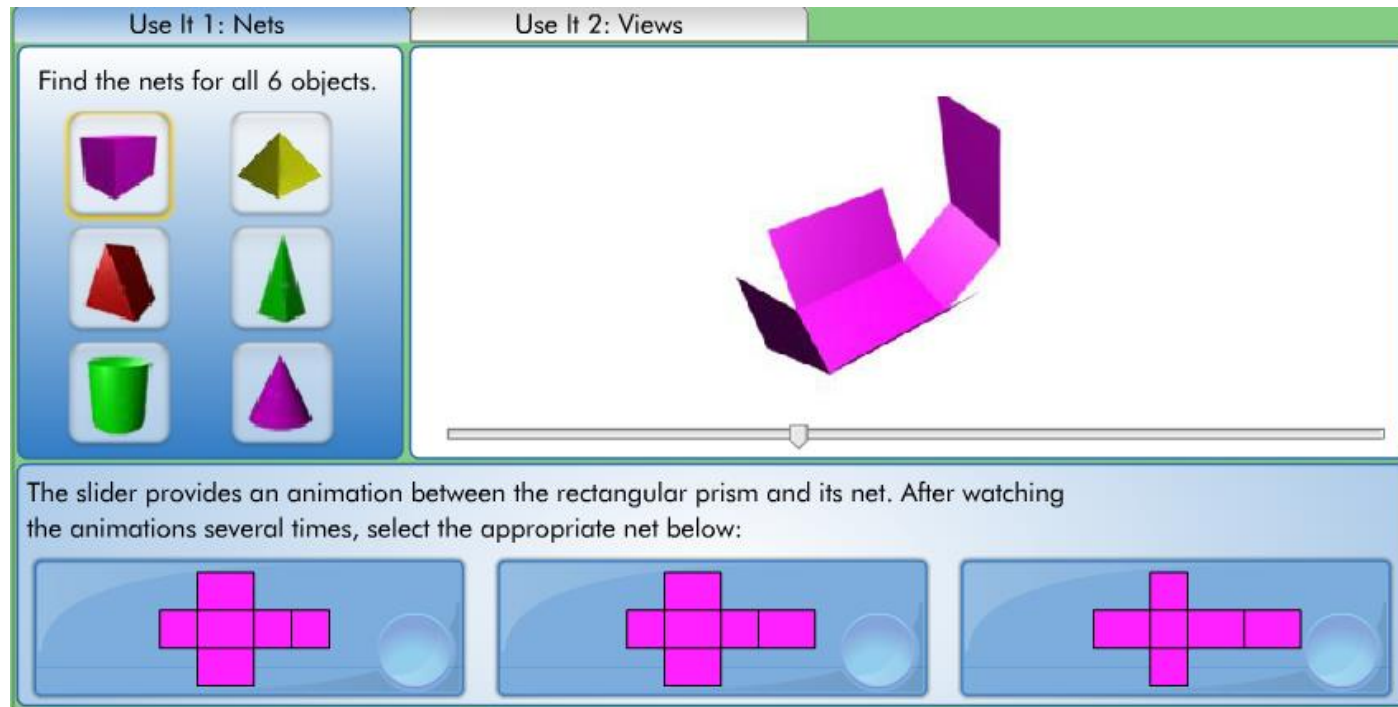
$$V = 224 \text{ cm}^3$$

Use Nets to “Catch” Some Skills

A **net** is the shape that is formed by unfolding a three-dimensional figure. In other words, a **net** is composed of all of the faces of the figure.

Using Nets to Find Surface Areas

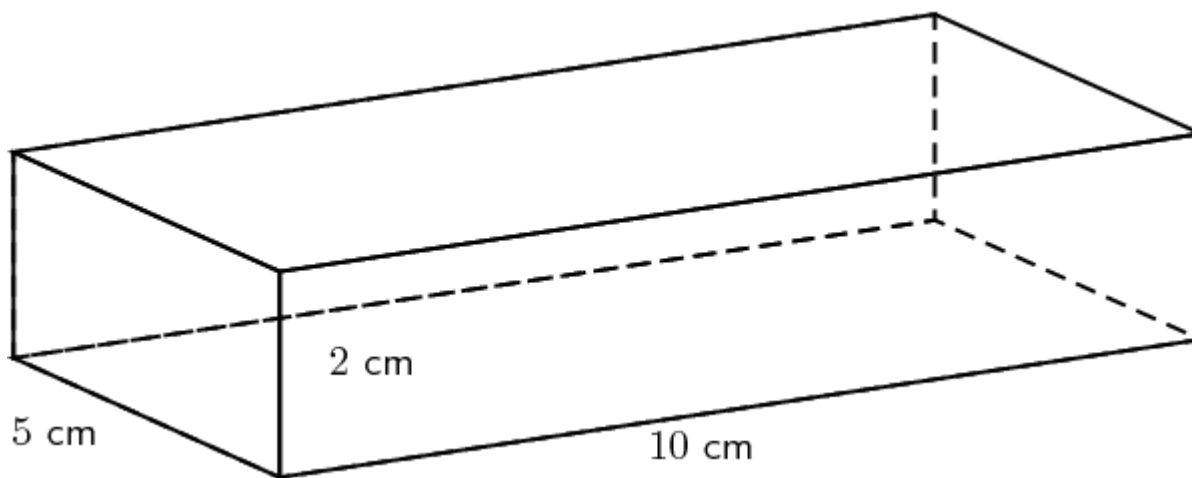
Math Interactives



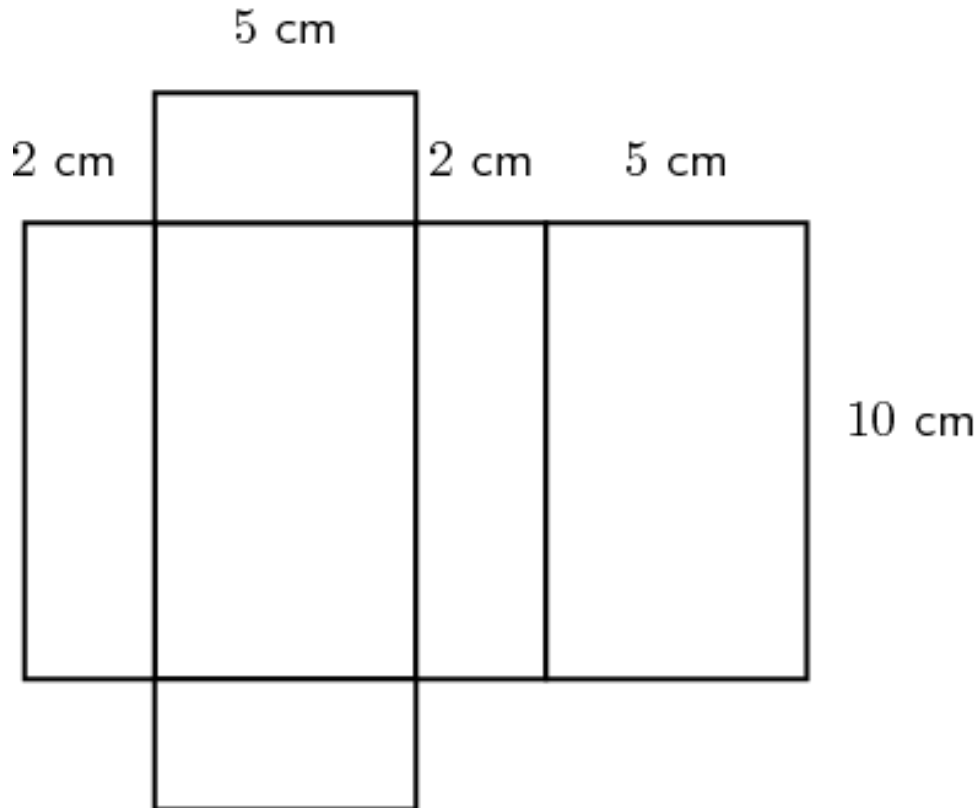
http://www.learnalberta.ca/content/mejhm/index.html?l=0&ID1=AB.MATH.JR.SHAP&ID2=AB.MATH.JR.SHAP.SURF&lesson=html/object_interactives/surfaceArea/use_it.html

Using Nets to Find Surface Areas

Find the surface area of the rectangular prism by using a net.



Using Nets to Find Surface Areas



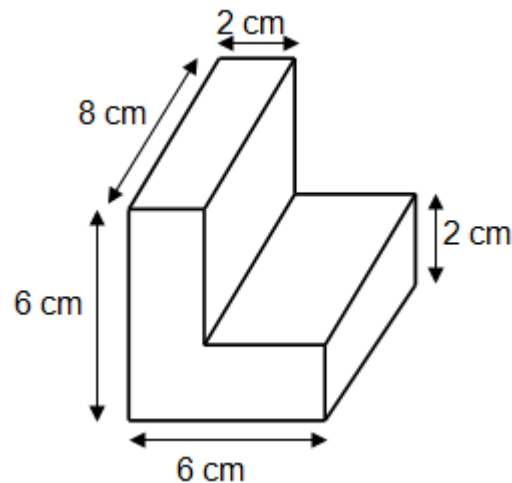
The surface area is 160 cm^2

Using Nets to Find Surface Area

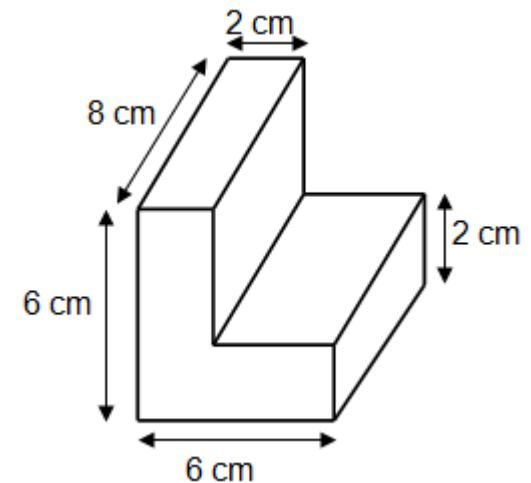
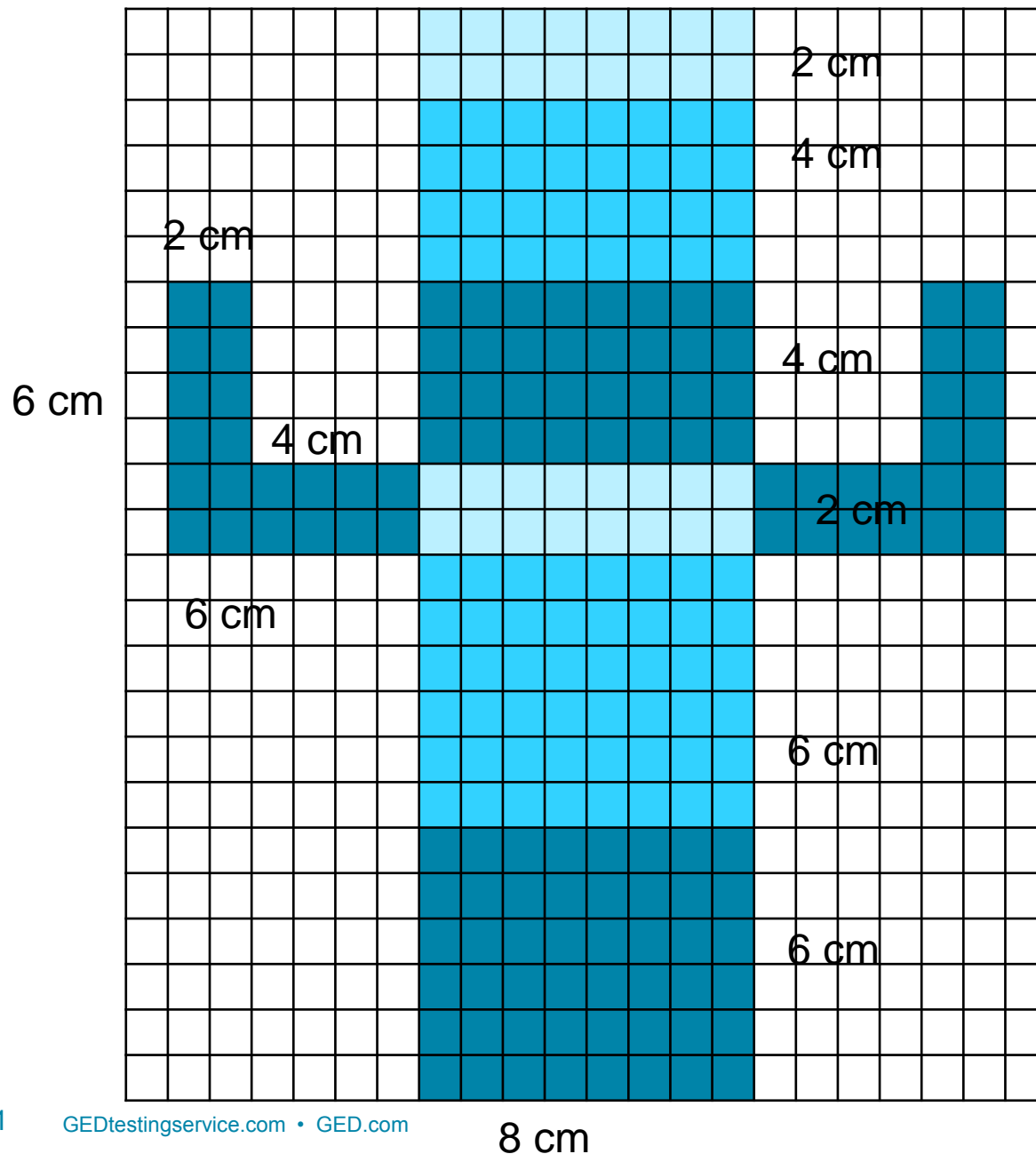
The diagram shows a prism constructed from two rectangular prisms.

Draw the net for the solid and mark the lengths.

Calculate the surface area of the solid.



Workbook pp. 18-19

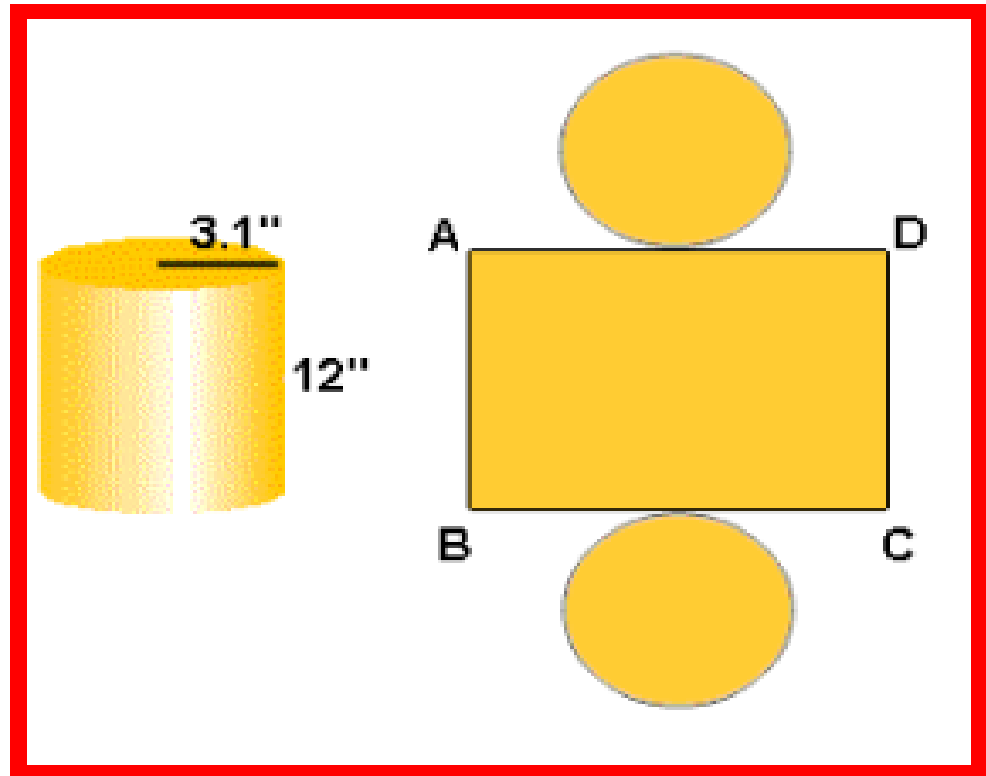


The surface area is 232 cm^2

Surface Area of a Cylinder

Imagine that you can open up a cylinder like so:

You can see that the surface is made up of two circles and a rectangle.



The length of the rectangle is the same as the circumference of the circle!

A scientist is studying red maple tree growth in a state park. She measured the trunk diameters of a sample of trees in the same month every other year. The tables show the data for two of the trees.

Tree 1

Year	Trunk Diameter (inches)
1	18.6
3	19.2
5	19.8
7	20.4
9	21.0
11	21.6
13	22.2

Tree 2

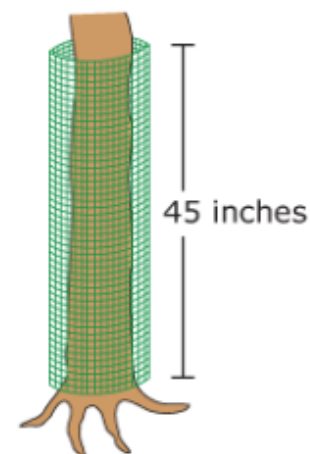
Year	Trunk Diameter (inches)
1	11.4
3	12.0
5	12.6
7	13.2
9	13.8
11	14.4
13	15.0

This is the final year in which she will collect data. When her data collection is complete, she will predict future red maple tree growth.

[Formula Sheet](#)[Calculator Reference](#)

In year 13, the scientist will put tree wrap around tree 1 to protect it from the winter snow. The height of the tree wrap needs to be 45 inches.

Tree Wrap



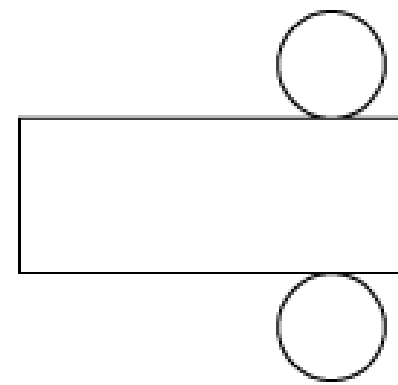
The wrap is priced by the square foot. To the nearest square foot, how many square feet of wrap does she need?

- ☐ A. 22
- ☐ B. 44
- ☐ C. 121
- ☐ D. 261

Let's Try It!

I want to paint the outside of a decorative pillar that has a height of 48 inches and a diameter of 16 inches. One small canister of paint will cover about 200 square inches. How many small canisters of paint will I need to paint the cylinder?

- What do I need to know?
- What type of net can I draw?
- What formula can I use?



From Words to Symbols

Translating Word Problems

What would your students do?

Mathematical Reasoning - Candidate Name

Question 14 of 16

☒ Answer Explanation ☐ Calculator

☐ Flag for Review

☐ Formula Sheet ☐ Calculator Reference

There are s steps from the pedestal to the head of the Statue of Liberty. The number of steps in the Washington Monument is 27 less than 6 times the number of steps in the Statue of Liberty. Which expression represents the number of steps in the Washington Monument in terms of s ?

☐ A. $27 < 6s$

☐ B. $6(s - 27)$

☐ C. $6s - 27$

☐ D. $6s < 27$

[< Previous](#) [Next >](#)

1. Guess
2. Select "C" because they haven't used it in a while
3. Skip it
4. Sign up for a retest

What students need to do!

1. Read the problem carefully and determine what you are trying to find
2. Assign a variable to the quantity that must be found
3. Write down what the variable represents
4. Write an equation for the quantities given in the problem
5. Solve the equation
6. Answer the question
7. Check the solution for reasonableness

Practice Translating

Jennifer has 10 fewer DVDs than Brad.

$$j - 10 = b \text{ (common answer, but incorrect)}$$

Insert the words and see the difference in the equation.

$$j \text{ (has)} = b \text{ (fewer)} - 10$$

so


$$j = b - 10$$

Use a Math Translation Guide

English	Math	Example	Translation
What, a number	$x, n, \text{etc.}$	Three more than a number is 8.	$n + 3 = 8$
Equals, is, was, has, costs	$=$	Danny is 16 years old. A CD costs 15 dollars.	$d = 16$ $c = 15$
Is greater than Is less than At least, minimum At most, maximum	$>$ $<$ \geq \leq	Jenny has more money than Ben. Ashley's age is less than Nick's. There are at least 30 questions on the test. Sam can invite a maximum of 15 people to his party.	$j > b$ $a < n$ $t \geq 30$ $s \leq 15$
More, more than, greater, than, added to, total, sum, increased by, together	$+$	Kecia has 2 more video games than John. Kecia and John have a total of 11 video games.	$k = j + 2$ $k + j = 11$
Less than, smaller than, decreased by, difference, fewer	$-$	Jason has 3 fewer CDs than Carson. The difference between Jenny's and Ben's savings is \$75.	$j = c - 3$ $j - b = 75$
Of, times, product of, twice, double, triple, half of, quarter of	\times	Emma has twice as many books as Justin. Justin has half as many books as Emma.	$e = 2 \times j$ or $e = 2j$ $j = c \times \frac{1}{2}$ or $j = e/2$
Divided by, per, for, out of, ratio of ___ to ___	\div	Sophia has \$1 for every \$2 Daniel has. The ratio of Daniel's savings to Sophia's savings is 2 to 1.	$s = d \div 2$ or $s = d/2$ $d/s = 2/1$

Reading and Reasoning in Mathematics

Steps to Success



*"Mathematics is no more
computation than
literature is typing."*

— John Allan Paulos, Ph.D.
Temple University

We need to help students . . .

 Formula Sheet

Build their
reading skills

 Calculator Reference

Type your answer in the box. You may use numbers, a decimal point (.), and/or a negative sign (-) in your answer.

Hartley opened a food truck business to sell food on the street. On day 2, the business earned \$112. On day 5, the business earned \$367. Hartley assumes that the earnings will continue to increase at the same rate. How much will the business earn on day 10?

\$

Build math
vocabulary

Depend less on
rote memory

Increase conceptual
knowledge

Two Essential Strategies

Helping students learn *how to learn* is critical to aiding the development of higher-order thinking skills

- **Modeling** is one way to teach students how to learn
- **Scaffolding** allows students to practice with diminishing support—to build confidence and competence

The Payoff for Students

- When higher-order thinking skills are used, students carry the knowledge longer.
- Knowledge gained from higher-order thinking processes is more easily transferrable...and that knowledge becomes accessible for solving new problems.

Reading and Reasoning Process

First Read: Read for Understanding

Second Read: Identify a Problem-Solving Process

Third Read: Solve the Problem and Check for Reasonableness

First Read: Read for Understanding

- Read through the problem aloud – noting your reactions to what you’re reading.
- What vocabulary do you not know?
- What’s the real-world context of the problem?
- Is there a picture that can help you visualize the problem?
- What questions are being asked?

Miller, P. and Koesling, D. “Mathematics Teaching for Understanding: Reasoning, Reading, and Formative Assessment.” Danvers, MA

First Read: Read for Understanding



An apartment building contains 12 units consisting of one- and two-bedroom apartments that rent for \$360 and \$450 per month, respectively. When all units are rented, the total monthly rental is \$4,950. What is the number of two-bedroom apartments?

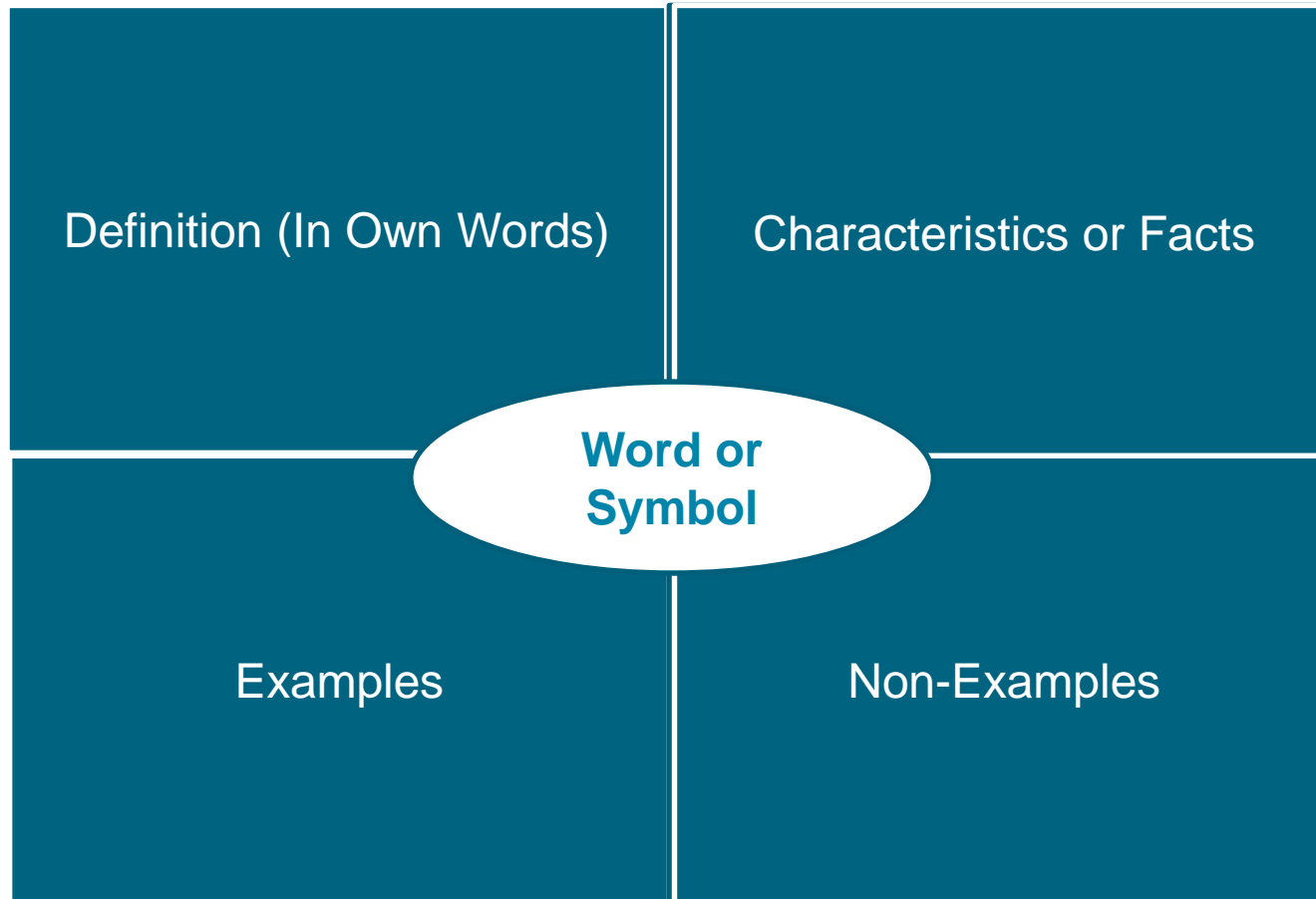


Tiered Vocabulary

Workbook p. 6

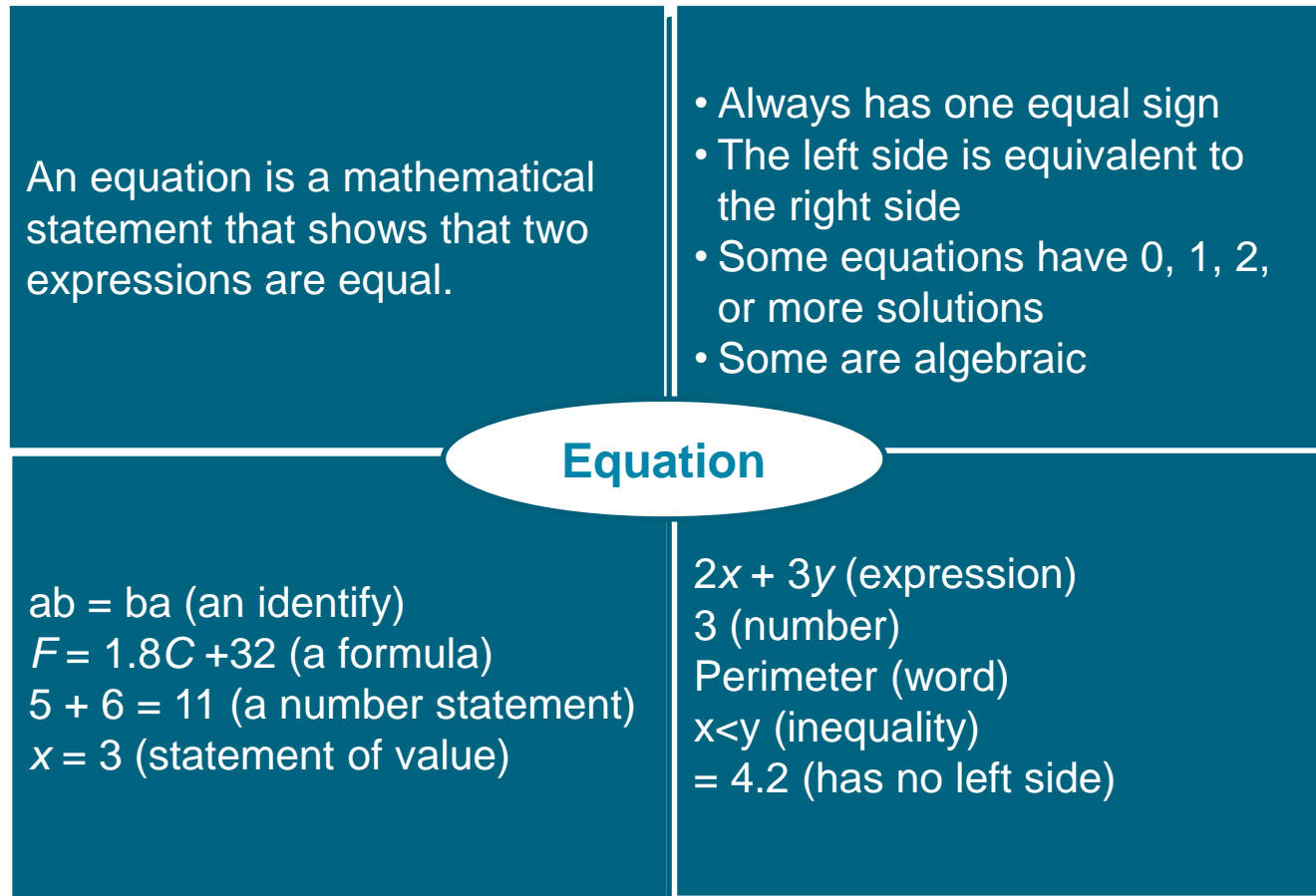
Absolute value	Additive inverse	Algorithm
Attribute	Constant	Distance formula
Exponent	Function	Dependent variable
Independent variable	Linear	Numerical expression
Profit	Property	Proportional gain
Rate of change	Strategy	Value

Building Vocabulary



Frayer Model – (Barton and Heidema, 2002)

Tools for Building Vocabulary



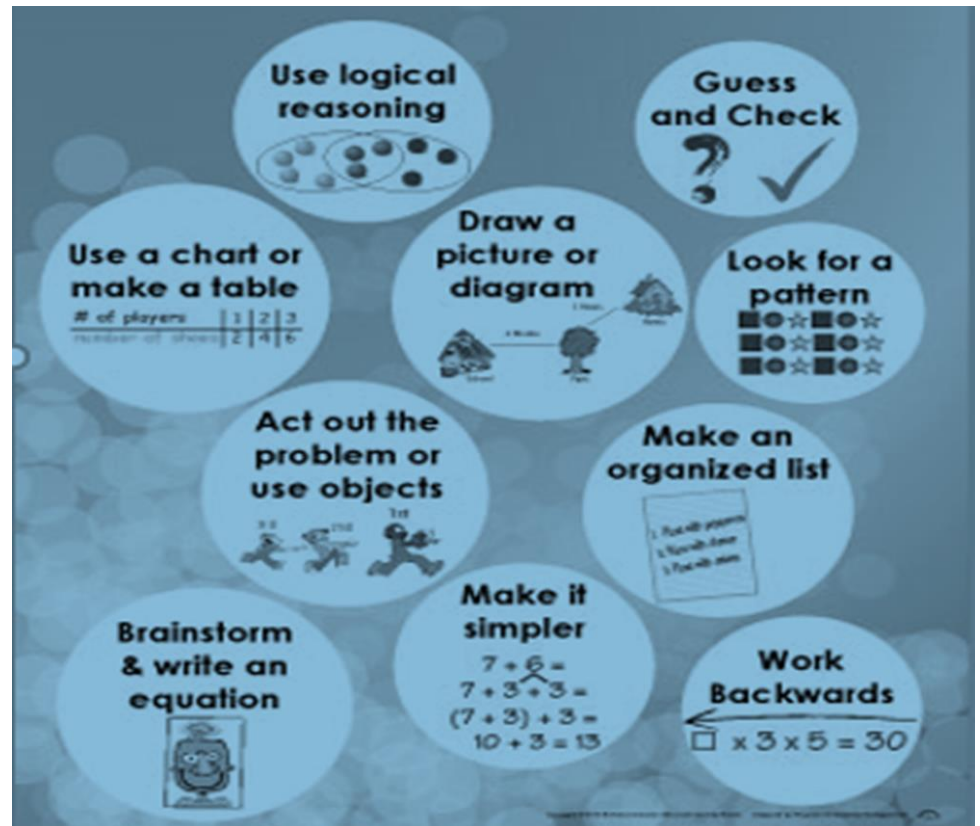
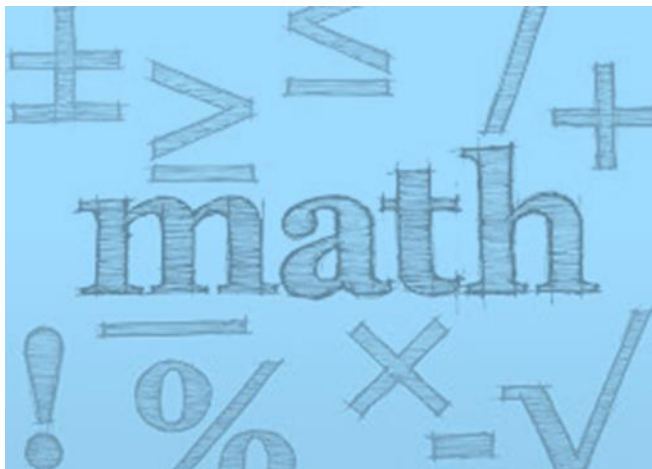
Frayer Model – (Barton and Heidema, 2002)

Second Read: Identify a Problem-Solving Process

- What is the pertinent information in this problem?
- What problem-solving strategies could I use?
- Which of those problem-solving strategies is best suited for this problem?
- How will I represent the problem in the symbolic language of mathematics?
- What mathematical details will I select as I reason and solve this problem?

Miller, P. and Koesling, D. "Mathematics Teaching for Understanding: Reasoning, Reading, and Formative Assessment." Danvers, MA

Second Read: Identify a Problem-Solving Process



Miller, P. and Koesling, D. "Mathematics Teaching for Understanding: Reasoning, Reading, and Formative Assessment." Danvers, MA

Begin with the Basics

Noticing

- Allows all students to participate
- Work independently or in groups
- What is stated in the problem
- What are the “givens” of the problem

Wondering

- Is the planning part
- Talk about strategies to use
- Restate the problem
- Pose questions about what they noticed
- Allows students to slow down and think
- Brainstorm, list, and discuss ideas

Try It!

Mathematical Reasoning - Candidate Name Question 10 of 16

☒ Answer Explanation ☐ Calculator ☐ Flag for Review

A scientist is studying red maple tree growth in a state park. She measured the trunk diameters of a sample of trees in the same month every other year. The tables show the data for two of the trees.

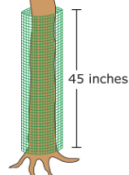
Year	Trunk Diameter (inches)
1	18.6
3	19.2
5	19.8
7	20.4
9	21.0
11	21.6
13	22.2

Year	Trunk Diameter (inches)
1	11.4
3	12.0
5	12.6
7	13.2
9	13.8
11	14.4
13	15.0

This is the final year in which she will collect data. When her data collection is complete, she will predict future red maple tree growth.

[Formula Sheet](#) [Calculator Reference](#)

In year 13, the scientist will put tree wrap around tree 1 to protect it from the winter snow. The height of the tree wrap needs to be 45 inches.



45 inches


The wrap is priced by the square foot. To the nearest square foot, how many square feet of wrap does she need?

☐ A. 22
☐ B. 44
☐ C. 121
☐ D. 261

[< Previous](#) [Next >](#)

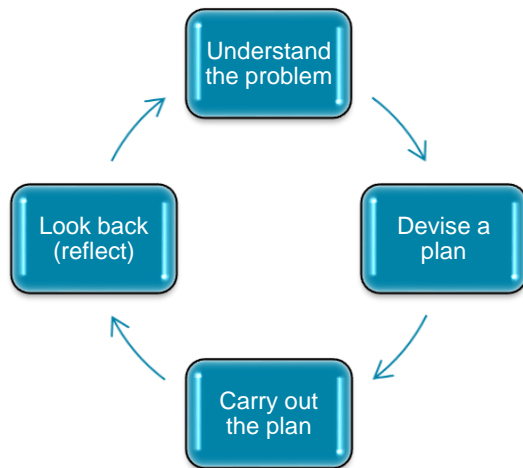
What do you notice?

What do you wonder?



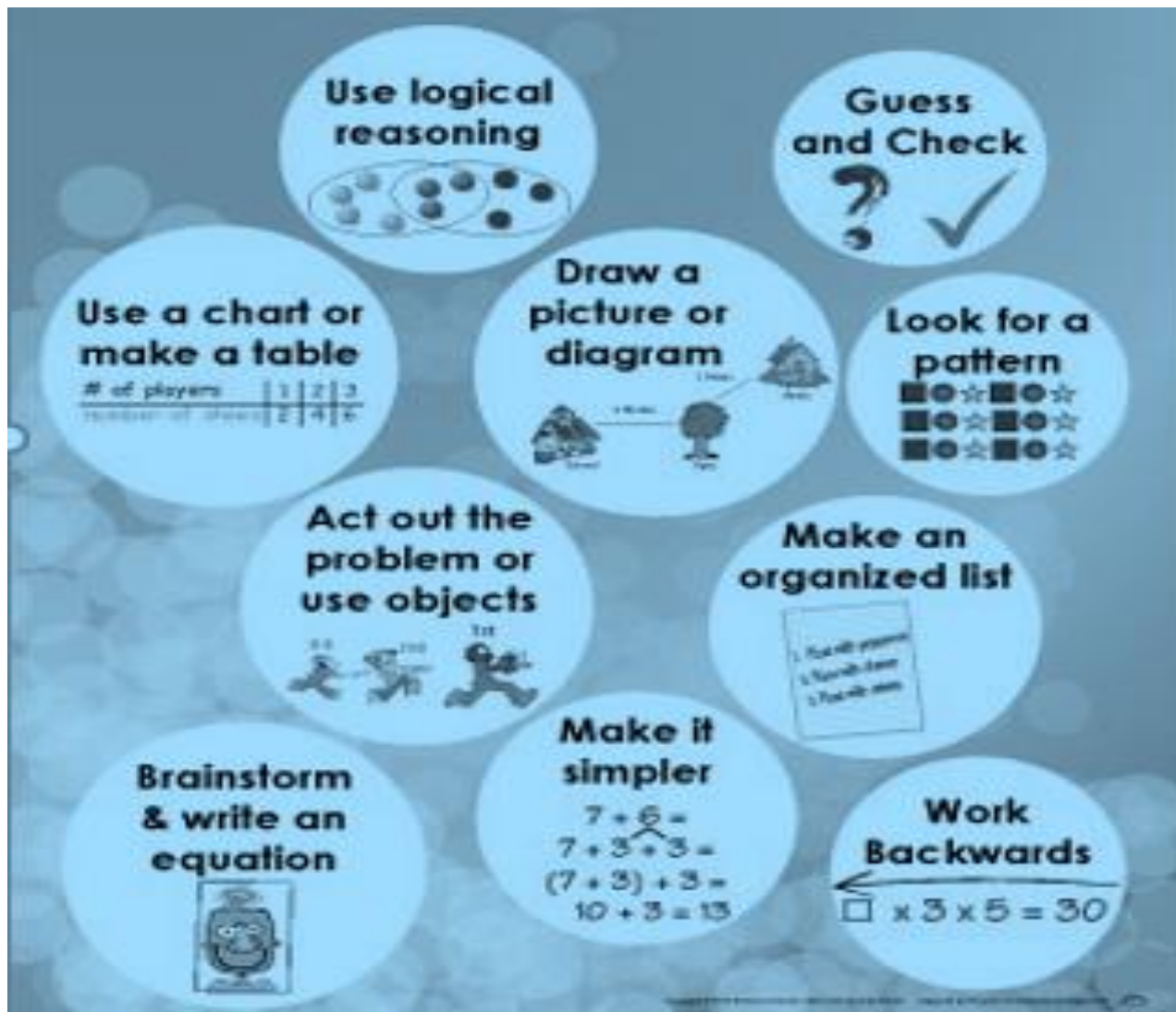
*It's better to solve one
problem five different
ways than to solve five
different problems.*

— George Polya, Mathematician
Stanford University



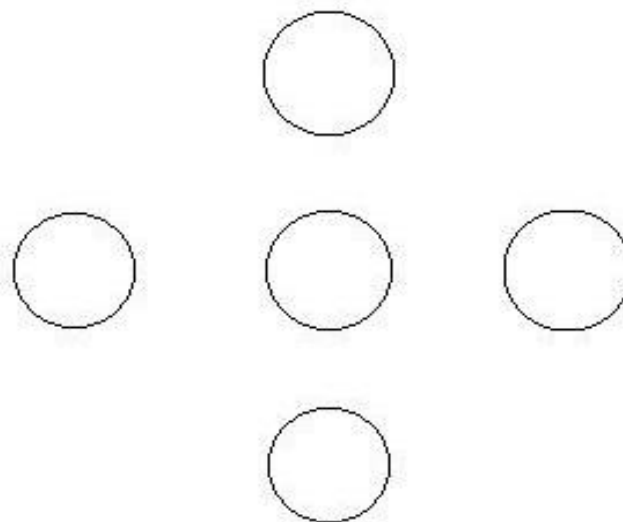
Must-Have Heuristics

Workbook p. 9



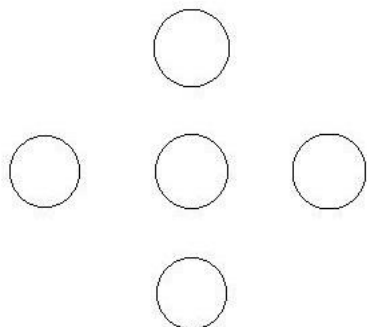
Strategy 1 - Guess and Check

Copy the figure below and place the digits 1, 2, 3, 4, and 5 in the circles so that sums across (horizontally) and down (vertically) are the same.



Guess and Check

Copy the figure below and place the digits 1, 2, 3, 4, and 5 in the circles so that sums across (horizontally) and down (vertically) are the same.



Possible solutions:

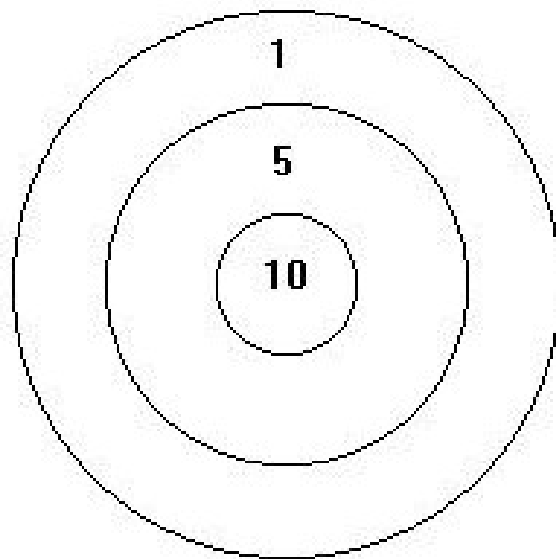
	2	
1	3	5
	4	

	3	
2	1	5
	4	

	2	
1	5	4
	3	

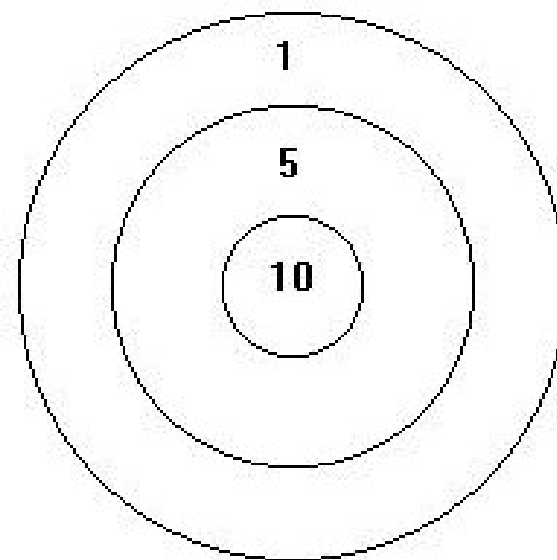
Strategy 2 - Make a List

Three darts hit this dart board and each scores a 1, 5, or 10. The total score is the sum of the scores for the three darts. There could be three 1's, two 1's and one 5, one 5 and two 10's, and so on. How many different possible total scores could a person get with three darts?



Make a List

# of 1's	# of 5's	# of 10's	Score
3	0	0	3
2	1	0	7
2	0	1	12
1	2	0	11
1	1	1	16
1	0	2	21
0	3	0	15
0	2	1	20
0	1	2	25
0	0	3	30



Strategy 3 - Draw a Diagram

In a stock car race, the first five finishers in some order were a Ford, a Pontiac, a Chevrolet, a Buick, and a Dodge.

- The Ford finished seven seconds before the Chevrolet.
- The Pontiac finished six seconds after the Buick.
- The Dodge finished eight seconds after the Buick.
- The Chevrolet finished two seconds before the Pontiac.

In what order did the cars finish the race? What strategy did you use?

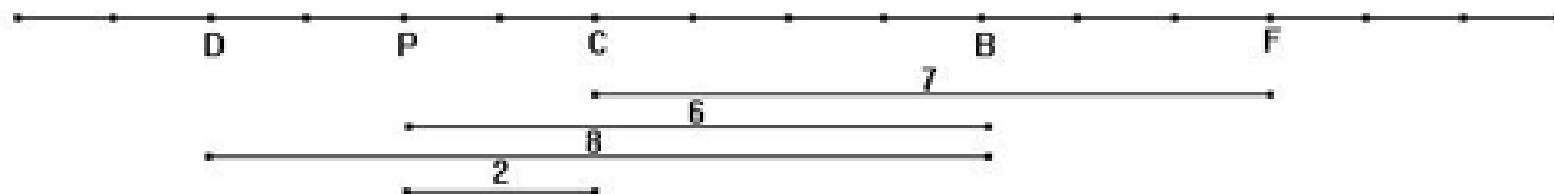


Draw a Diagram

In a stock car race, the first five finishers in some order were a Ford, a Pontiac, a Chevrolet, a Buick, and a Dodge.

- The Ford finished seven seconds before the Chevrolet.
- The Pontiac finished six seconds after the Buick.
- The Dodge finished eight seconds after the Buick.
- The Chevrolet finished two seconds before the Pontiac.

In what order did the cars finish the race? What strategy did you use?



The order is: Ford, Buick, Chevrolet, Pontiac, Dodge.

Strategy 4 - Make a Table or Chart



South Point Amusement Park has a special package for large groups: a flat fee of \$20 and \$6 per person.

If a club has \$100 to spend on admission, what is the largest number of people who can attend?

Make a Table or Chart

South Point Amusement Park has a special package for large groups: a flat fee of \$20 and \$6 per person.

If a club has \$100 to spend on admission, what is the largest number of people who can attend?

# of people	Cost X \$6	+ \$20	Total fee	Result
10	60	20	80	Too low
15	90	20	110	Too high
13	78	20	98	Too low
14	84	20	104	Too high

Answer: At most, 13 people can attend for \$100 and they will have \$2 left over.

Strategy 5 - Find a Pattern

Continue these numerical sequences by finding the next three numbers for each group.

1, 4, 7, 10, 13, _____, _____, _____

19, 20, 22, 25, 29, _____, _____, _____

2, 6, 18, 54, _____, _____, _____

Find a Pattern

Continue these numerical sequences by finding the next three numbers for each group.

1, 4, 7, 10, 13, ____, ____, ____ (add 3 to the previous term)

1, 4, 7, 10, 13, 16, 19, 22

19, 20, 22, 25, 29, ____, ____, ____ (add 1 to the previous term, then add 2 to that term, then add three to that term)

19, 20, 22, 25, 29, 34, 40, 47

2, 6, 18, 54, ____, ____, ____ (multiply the previous term by 3 to generate the next term)

2, 6, 18, 54, 162, 486, 1458

Strategy 6 - Make it Simpler

The houses on Main Street are numbered consecutively from 1 to 150.

How many house numbers contain at least one digit 7?



Make it Simpler

The houses on Main Street are numbered consecutively from 1 to 150.

How many house numbers contain at least one digit 7?

Break the problem down. First determine how many houses have a seven in the units place. (15)

7, 17, 27, 37, 47, 57, 67, 77, 87, 97, 107, 117, 127, 137, 147

Next, determine how many houses have a seven in tens place. (10)

70, 71, 72, 73, 74, 75, 76, 77, 78, 79

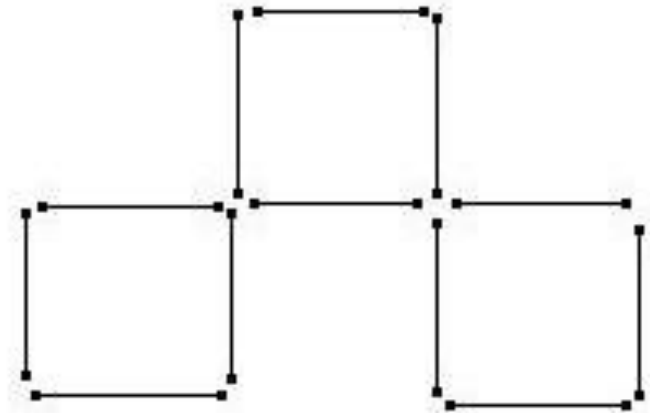
Take out any duplicates (1)

Answer – 24 houses contain at least one digit 7.

Strategy 7 - Act It Out or Use Objects

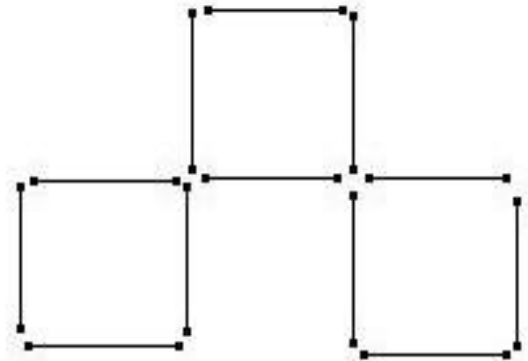
The figure shows twelve toothpicks arranged to form three squares.

How can you form five squares by moving only three toothpicks?

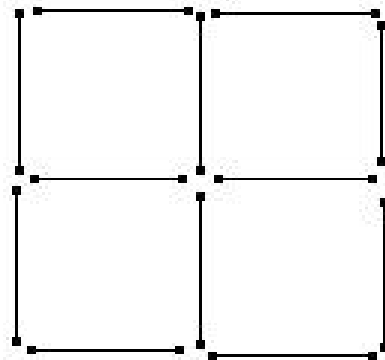


Act It Out or Use Objects

The figure shows twelve toothpicks arranged to form three squares. How can you form five squares by moving only three toothpicks?



Answer: One of the squares is formed by the outer boundary of the arrangement. There was no requirement that each of the five squares must be congruent to each of the others.



Strategy 8 - Work Backwards



Brady was trying to decide when to get up in the morning. He needs 45 minutes to get ready for the workshop he plans to attend. It takes him 25 minutes to drive to the adult center where the workshop will be held. He wanted to get to the center 20 minutes early to stop by his classroom and pick up some materials. If the session starts at 7:30 a.m., what time should he get up, if he wants to give himself 10 extra minutes in case the traffic is bad?

Work Backwards

Brady was trying to decide when to get up in the morning. He needs 45 minutes to get ready for the workshop he plans to attend. It takes him 25 minutes to drive to the adult center where the workshop will be held. He wanted to get to center 20 minutes early to stop by his classroom and pick up some materials. If the session starts at 7:30 a.m., what time should he get up, if he wants to give himself 10 extra minutes in case the traffic is bad?

Start with the time he has to be at the workshop – 7:30

He needed 20 minutes to go by the classroom – 7:10

He drove for 25 minutes – 6:45

He needed 45 minutes to get ready – 6:00

To allow for 10 minutes in case the traffic was bad – 5:50

Strategy 9 - Brainstorm and Write an Equation

Two apples weigh the same as a banana and a cherry. A banana weighs the same as nine cherries. How many cherries weigh the same as one apple?



Brainstorm and Write an Equation

Two apples weigh the same as a banana and a cherry. A banana weighs the same as nine cherries. How many cherries weigh the same as one apple?

You will need to use three variables.

- A = the weight of an apple
- B = the weight of a banana
- C = the weight of a cherry

$$2A = B + C$$

$$B = 9C$$

$$\text{Substituting: } 2A = 9C + C$$

$$2A = 10C \quad A = 5C$$

Answer: 5 cherries weigh the same as 1 apple

Strategy 10 – Use Logical Reasoning

Three apples and two pears cost 78 cents. However, two apples and three pears cost 82 cents. What is the total cost of one apple and one pear?

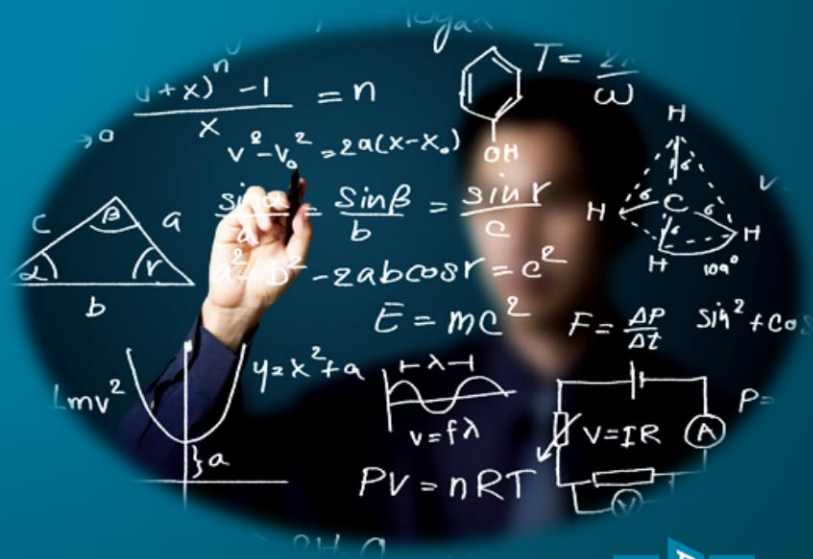
Third Read: Solve the Problem and Check for Reasonableness

- Now that I understand the problem's content, how can I best use my math skills to solve the problem?
- Am I answering the right question?
- How should the answer to the question be expressed?

Miller, P. and Koesling, D. "Mathematics Teaching for Understanding: Reasoning, Reading, and Formative Assessment." Danvers, MA

Routines for Problem Solving

Mathematical Problem Solving in the Classroom



Goals and Givens

Active Reading Strategy for Problem Solving

- Read problem closely
- Identify the goal – the task(s) to be completed
 - Paraphrase what author wants to be done
 - Write in own words
- Identify the givens – information relevant to solving the task
 - Look for key terms

Goals and Givens Template

Goal: What is the question?	Givens: Important details / information that is provided
Plan: What strategies will you use? May have multiple checked. Circle the one that was most effective.	
<div style="display: flex; flex-wrap: wrap;"> <div style="width: 33%;"><input type="checkbox"/> Draw and Label Diagram/Picture</div> <div style="width: 33%;"><input type="checkbox"/> Look for patterns</div> <div style="width: 33%;"><input type="checkbox"/> Write an equation</div> <div style="width: 33%;"><input type="checkbox"/> Look for special cases</div> <div style="width: 33%;"><input type="checkbox"/> Make a table</div> <div style="width: 33%;"><input type="checkbox"/> Work backwards</div> <div style="width: 33%;"><input type="checkbox"/> Create and solve a simpler problem</div> <div style="width: 33%;"><input type="checkbox"/> Compare to a similar Problems you have solved</div> <div style="width: 33%;"><input type="checkbox"/> Other _____</div> </div>	
Conjecture: (reasonable guess) Predict your answer and any reasoning that results in your predicted answer	
Solution: (make no assumptions, label everything) <ul style="list-style-type: none"> Start Solving using your plan from above Move vertically with your work Show/document ALL work <ul style="list-style-type: none"> Do NOT make any assumptions Continue to refer to the word problem Be precise and label units while solving & when you have reached a final answer Persevere! Keep trying even if it means that you need to change your plan. (trying a new strategy) Go as far as you can! 	

Solution: (make no assumptions, label everything)
Answer: (complete sentence answering the goal. Include proper units, notation, etc.) Write a complete sentence that answers your goal with appropriate units.
Verification: (Explain why your answer makes sense, why it is reasonable, did you answer the goal, is there another strategy that proves your answer is correct?) How do you know your answer is correct? Is your answer reasonable? Did your answer the goal? Can you convince someone using another method?

Goal/Givens 1 pt	Conjecture 1 pt	Plan 1 pt	Solution 2 pts	Verification 2 pts	Answer 3 pts
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How Does It Work? Let's Start Easy

A bag of M&M's® has 96 pieces in three colors, red, blue, and yellow. The bag has twice as many red M&M's® as blue and five times as many blue as yellow. How many M&Ms of each color are in the bag?



Goals and Givens

Goals		Givens	
Find out how many M&M's® of each color are in the bag.		Total of 96 pieces 3 colors – red, blue, yellow 2x red = blue 5x blue = yellow	
What strategies will you use? May have multiple checked.			
<input type="checkbox"/> Draw/label Diagram <input type="checkbox"/> Guess and Check <input type="checkbox"/> Make it Simpler	<input type="checkbox"/> Look for patterns <input checked="" type="checkbox"/> Make a table <input type="checkbox"/> Act out or use objects	<input checked="" type="checkbox"/> Write an equation <input type="checkbox"/> Word backwards <input type="checkbox"/> Other_____	

Solve It!

Make a Table				Write an Equation	
				Write an equation. Use substitution. $r + b + y = 96$ $r + b + y = 96$ ($r = 2b$ and $b = 5y$) $2b + b + y = 96$ (substitute $r = 2b$) $2(5y) + 5y + y = 96$ (substitute $b = 5y$) $10y + 5y + y = 16y = 96$ so $y = 6$ $y = 6, b = 30, r = 60$	
Red	Blue	Yellow	Total		
20	10	2	32		
30	15	3	48		
40	20	4	64		
50	25	5	80		
60	30	6	96		

Use Goals and Givens!

Workbook p. 16

Mathematical Reasoning - Candidate Name

Question 10 of 16

☒ Answer Explanation ☐ Calculator

☐ Flag for Review

A scientist is studying red maple tree growth in a state park. She measured the trunk diameters of a sample of trees in the same month every other year. The tables show the data for two of the trees.

Tree 1		Tree 2	
Year	Trunk Diameter (inches)	Year	Trunk Diameter (inches)
1	18.6	1	11.4
3	19.2	3	12.0
5	19.8	5	12.6
7	20.4	7	13.2
9	21.0	9	13.8
11	21.6	11	14.4
13	22.2	13	15.0

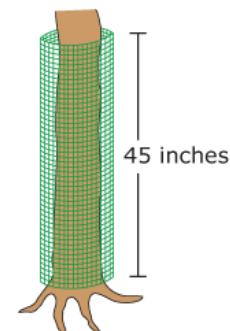
This is the final year in which she will collect data. When her data collection is complete, she will predict future red maple tree growth.

☐ Formula Sheet

☐ Calculator Reference

In year 13, the scientist will put tree wrap around tree 1 to protect it from the winter snow. The height of the tree wrap needs to be 45 inches.

Tree Wrap



The wrap is priced by the square foot. To the nearest square foot, how many square feet of wrap does she need?

- ☐ A. 22
- ☐ B. 44
- ☐ C. 121
- ☐ D. 261

← Previous Next →

Posing Purposeful Questions

Posing Purposeful Questions

Effective teaching of mathematics uses purposeful questions to assess and advance students' reasoning and sense making about important mathematical ideas and relationships.

Four Types of Questions

1. Gathering Information
2. Probing Thinking
3. Making the mathematics visible
4. Encouraging reflection and justification

Effective Teaching and Learning. (2014). In *Principles to Actions : Ensuring mathematical success for all* (p. 36). Reston, VA: NCTM.

Purposeful Questions

Question type	Description	Examples
Gathering information	Students recall facts, definitions, or procedures.	<ul style="list-style-type: none"> When you write an equation, what does the equal sign tell you? What is the formula for finding the area of a rectangle?
Probing thinking	Students explain, elaborate, or clarify their thinking, including articulating the steps in solution methods or the completion of a task.	<ul style="list-style-type: none"> As you drew that number line, what decisions did you make so that you could represent $7\frac{1}{4}$ on it? Can you show and explain more about how you used a table to find the answer to the Smartphone Plans task?

Effective Teaching and Learning. (2014). In *Principles to Actions : Ensuring mathematical success for all* (p. 36). Reston, VA: NCTM.

Purposeful Questions

Question type	Description	Examples
Making the mathematics visible	Students discuss mathematical structures and make connections among mathematical ideas and relationships.	<ul style="list-style-type: none"> ▪ What does your equation have to do with the band concert situation? ▪ How does that array relate to multiplication and division?
Encouraging reflection and justification	Students reveal deeper understanding of their reasoning and actions, including making an argument for the validity of their work.	<ul style="list-style-type: none"> • How might you prove that 51 is the solution? • How do you know that the sum of two odd numbers will always be even?

Effective Teaching and Learning. (2014). In *Principles to Actions : Ensuring mathematical success for all* (p. 36). Reston, VA: NCTM.

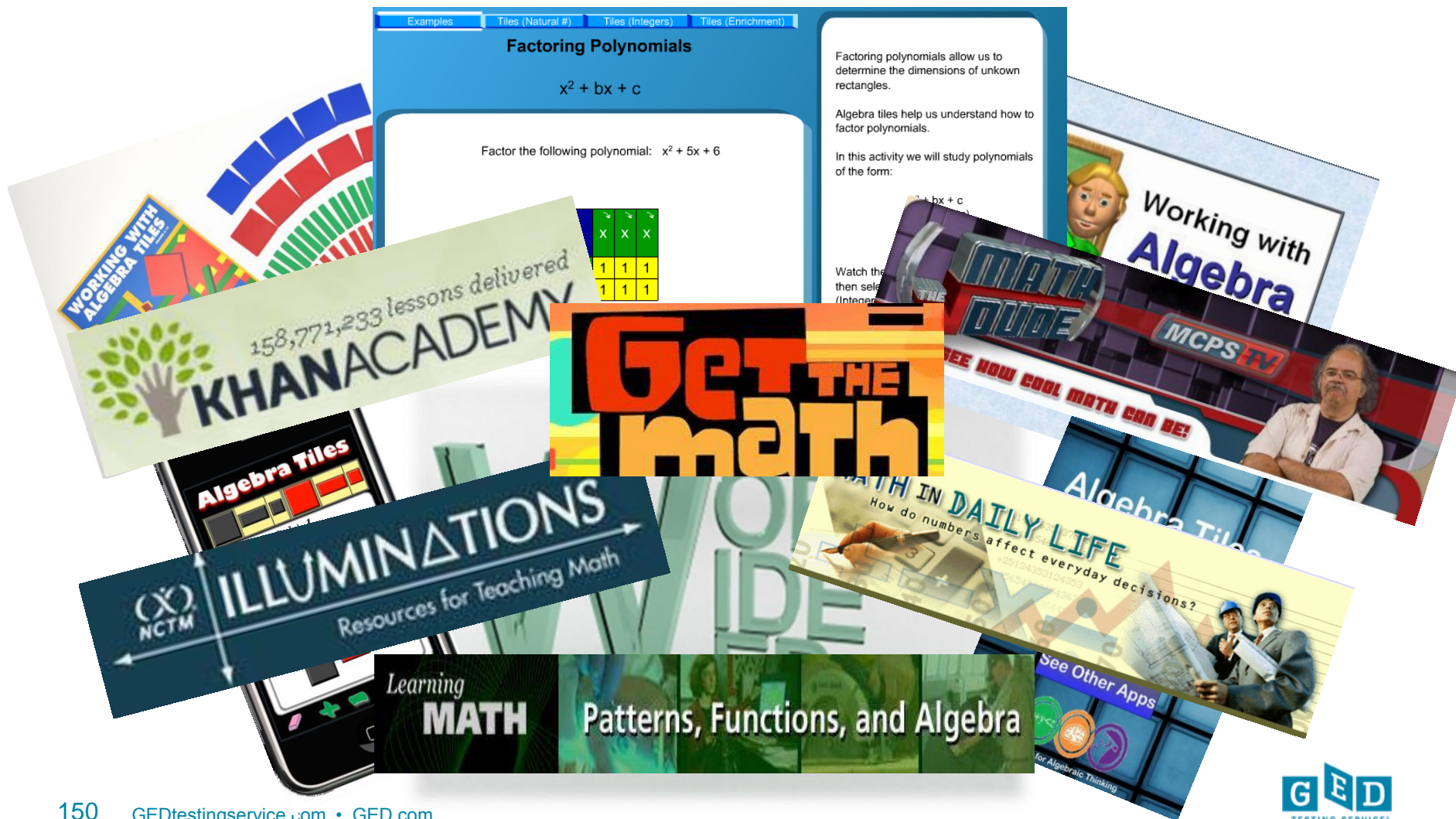
The Challenge

- Increase instruction on problem-solving strategies
- Increase emphasis on geometric and algebraic thinking
- Provide instruction in higher-order mathematics
- Shift focus from “rules or processes” of mathematics to deeper understanding of “why”
- Incorporate close-reading strategies into the math classroom
- Have high expectations of all students

Final Tools and Tips

Resources


Workbook p. 52-53



Calculator Resources

Calculator Tutorial

Calculator



Welcome to the GED® Test Calculator Tutorial

To begin, look at the lower right corner of the screen.

Click the Next button.

2014 GED® Test Resources

GED TESTING SERVICE®

TI-30XS Calculator Reference Sheet

The calculator reference sheet is provided on most items on the 2014 GED® Mathematical Reasoning test, as well as certain items on the Scientific Reasoning and Social Studies tests. The calculator reference sheet is provided to test-takers in order to demonstrate the functionality of the onscreen calculator, specifically in terms of what order to click the buttons in complex problems, such as order of operations or calculating with fractions.

BASIC ARITHMETIC

To perform basic arithmetic, enter numbers and operation symbols using the standard order of operations.

EXAMPLE

$8 \times -4 + 7 =$

Buttons: 8, ×, (-), 4, +, 7, =

The correct answer is **-25**

PERCENTAGES

To calculate with percentages, enter the number, then the % key.

EXAMPLE

$40\% \times 560 =$

Buttons: 4, 0, %, ×, 5, 6, 0, =

The correct answer is **224**

SCIENTIFIC NOTATION

To perform calculations with scientific notation, use the $\times 10^x$ key.

EXAMPLE

$7.8 \times 10^8 - 1.5 \times 10^8 =$

Buttons: 7, ., 8, $\times 10^x$, 8, -, 1, ., 5, $\times 10^x$, 8, =

The correct answer is **630000000**

The answer will automatically be

Buttons: 2, 1, =

The correct answer is **$\frac{2}{21}$**

Introduction to the
GED® Test TI-30XS
On-screen Scientific Calculator

Q & A

WHICH? about? help? why? what? who?

HOW answers

WHERE? why? WHEN? which? how?

WHY? when?

FAQ

Thank you!