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MATH MANIA



**Immersive
Institute**

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INTERACTABLE OBJECTS

2 nd – 12 th Grade	121
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2nd Grade

Basic Operations & Reasoning | Adding & Subtracting Within 20

Adding with Place Value Blocks

Use Place Value Blocks to visualize addition. (2 min)

Addition with 10 Frames

Use Frames to visualize addition with base 10. (3 min)

Adding 7+6

Learn how to add 7+6 using the Number Line. (4 min)

Adding 8+7

Learn how to add 8+7 by making a group of ten. (3 min)

Subtracting with a Number Line

Use a number line to solve a subtraction problem. (1 min)

Subtraction Using Place Value Blocks

Use Place Value Blocks to visualize Subtraction. (1 min)

Adding with Arrays

Learn to break down an array and add with it. (2 min)

Addition Based on Arrays Word Problems

Learn how to use arrays to solve word problems. (2 min)

Repeated Addition Example: Haircuts

Learn how to solve word problems by adding the same number many times. (2 min)

Subtraction with 10 Frames

Use Frames to subtract 13-6. (1 min)

Subtracting 14-6

Learn how to subtract 14-6 by first thinking about subtracting 2 and 4. (4 min)

Addition & Subtraction Word Problems: Gorillas

Use Arrays to solve a word problem about gorillas. (6 min)

Addition & Subtraction Word Problems: Superheroes

Solve a subtraction word problem using deductive reasoning. (4 min)

Basic Operations & Reasoning | Place Value

Intro to Place Values

Learn the Basics of Base 10 Numbers. (3 min)

Identifying Value in Digits

Learn how to identify value in different number digits. (3 min)

Creating the Largest Number

Visual Examples of how to create the largest 3-digit number. (3 min)

Expanded Form of Numbers

Expand numbers to visualize the hundreds, tens, and one's spot of numbers. (3 min)

Number and Word Form of a Number

Expand numbers to visualize the hundreds, tens, and one's spot of numbers. (2 min)

Word Form and Expanded Form

Differentiate between expanded word form and expanded number form. (1 min)

Use Place Value Blocks to show Numbers within 1,000

Visualize Place Value to 1,000 by using Place Value Blocks. (4 min)

Counting by 10s

Students learn to count by 10s using visual examples. (2 min)

Place Value Tables within 1,000

Students will use Place Value Tables to visualize place value of 1000. (3 min)

Skip-Counting by 5s

Work on a problem and solve it by skip counting by 5. (2 min)

Skip-Counting by 100s

Learn to count by hundreds in this visual exercise. (3 min)

Greater Than and Less Than Symbols

Learn the greater than symbol and the less than symbol. (5 min)

Comparing Whole Numbers

Learn how to compare whole numbers. (2 min)

Regrouping Whole Numbers: 675

Visualize how regrouping whole numbers doesn't change the outcome of the number. (4 min)

Understanding Even and Odd Numbers Visually

Visually see the difference between even and odd numbers. (4 min)

Basic Operations & Reasoning | Add & Subtract Within 100

Adding 2-Digit Numbers Without Regrouping

Use Place Value to add 2-digit numbers. (2 min)

Understanding Place Value when Adding Ones

Learn how to add 37 + 2 by thinking about place value. (2 min)

Understanding Place Value when Adding Tens

Learn how to add 23 + 30 by thinking about place value. (3 min)

Adding with Regrouping

Use Regrouping to Add $35 + 27$ in this exercise. (4 min)

2.NBT. 1 | Addition and Subtraction with Number Lines

Learn to see three-digit numbers as hundreds, tens, and ones. (2 min)

Breaking Apart 2-Digit Addition Problems

Visualize different ways to break apart addition problems. (5 min)

Adding $53+17$ by Making Groups of 10

Learn addition within a 100 using $53+7$. (3 min)

Adding by Making a Group of 10

Using groups of 10 to add. (3 min)

Strategies for Adding 2-Digit Numbers

Visualize different strategies to add 2-digit numbers. (3 min)

Subtracting 1s using Place Value

Learn how to subtract 4 from 46 by thinking about place value. (2 min)

Subtracting 10s using Place Value

Learn how to subtract 40 from 65 by thinking about place value. (2 min)

Subtracting 2-Digit Numbers Without Regrouping

Learn how to subtract 31 from 64 by thinking about tens and ones. (2 min)

Subtracting a 1-Digit Number with Regrouping

Learn how to subtract $35-8$ using regrouping. (3 min)

Missing Numbers in Addition and Subtraction

Solve a problem with a missing number in the problem. (6 min)

Addition Word Problems: Horses

Solve a word problem about horses using addition. (3 min)

Subtraction Word Problem: Crayons

Solve a subtraction word problem about crayons. (4 min)

Subtraction Word Problem: Basketball

Solve a subtraction problem about basketball. (2 min)

Adding and Subtracting on Number Line Word Problems

Use a number line to solve a word problem. (4 min)

Adding Two Digit Numbers on a Number Line

Use a number line to solve an addition problem with 2-digit numbers. (3 min)

Multi-Step Addition Word Problems

Use addition multiple times to solve a word problem. (4 min)

Multi-Step Subtraction Word Problems

use Subtraction multiple times to solve a word problem. (4 min)

Basic Operations & Reasoning | Add & Subtract within 1,000

Adding 10 or 100

Use place value blocks to add 10s or 100s. (4 min)

Adding 1s, 10s, and 100s

Use place value blocks to add 100s, 10s, and 1s. (4 min)

Adding and Subtracting on Number Line

Learn to add and subtract numbers like 585 and 368 using a number line. (3 min)

Adding 3-Digit Numbers (No Regrouping)

Learn to add $327 + 251$ by utilizing place value. (3 min)

Addition using Groups of 10 and 100

Learn to rewrite addition problems to make them easier to solve. (4 min)

Breaking Apart 3-Digit Addition Problems

Visualize different ways to break up addition problems using place value. (4 min)

Subtracting 1,10, and 100

Learn how to subtract 1s, 10s, and 100s through place value blocks. (4 min)

Subtracting 1s, 10s, and 100s

Learn how to subtract 1s, 10s, and 100s through place value blocks (3 min)

Subtracting 3-Digit Numbers

Learn how to subtract $357-251$ with place value blocks. (3 min)

Subtracting with Place Value Blocks (Regrouping)

Learn how to use place value blocks to regroup and subtract $438-272$. (3 min)

Adding Four 2-Digit Numbers

Learn how to add 4 2-digit numbers at a time. (3 min)

Adding Multiple 2-Digit Numbers: Word Problems

Solve a word problem by adding multiple 2-digit numbers. (3 min)

Basic Operations & Reasoning | Money & Time

Counting American Coins

Learn to differentiate and count American coins. (4 min)

Counting Dollars

Learn to differentiate and count American dollars. (3 min)

Time on a Number Line

Use a timeline to visualize time. (2 min)

Telling Time (Labeled Clock)

Learn to tell time on an analog clock in this exercise. (3 min)

Geometry | Shapes & Parts of Shapes

Recognizing Shapes

Learn how to identify circles, triangles, squares, rectangles, rhombuses, and trapezoids. (6 min)

Cousin Fal's Shape Collection

Learn how to classify shapes based on their number of sides, number of corners, and side-lengths. (4 min)

Shapes and Angles

Learn about shapes and angles and how to identify them. (3 min)

Equal Parts of Circles and Rectangles

Learn to identify equal parts of a circle and rectangle. (3 min)

Partitioning Rectangles

Follow along as a rectangle is broken into multiple equal parts up to 2 rows and 5 columns. (3 min)

Measurement & Data | Measurement

Getting a Sense of Meters and Centimeters

See how a meter is broken down into centimeters and how they relate to each other. (6 min)

Getting a Sense of Inches and Feet

See how a foot is broken down into inches and how they relate to each other. (6 min)

Measuring in Inches

Measures a flower in inches. (1 min)

Measuring Lengths (cm, m)

Measure various objects with a ruler. (5 min)

Measuring lengths in Different Units

Measures the same rectangle in different units and then compares the size of the different units. (3 min)

Estimating Lengths

Estimates the length of an object when given the length of another object. (2 min)

Length Word Problem: US Customary

Solve a length word problem example. (4 min)

Length Word Problem: Chalk Lines

Solve a length word problem with addition and subtraction. (6 min)

Measurement & Data | Data

Picture Graphs

A picture graph, or pictograph, is a graph used to display information that uses images or symbols to represent data. (3 min)

Making Picture Graphs and Line Plots

To create a line plot, first create a number line that includes all the values in the data set. Next, place an X (or dot) above each data value on the number line. (3 min)

Creating a Bar Graph

Create a bar chart using data from a survey. (1 min)

Reading Bar Graphs: Bikes

Learn to read and interpret bar graphs. (1 min)

Read Line Plots

A line plot is a graph that displays data using a number line. To create a line plot, first create a number line that includes all the values in the data set. Next, place an X (or dot) above each data value on the number line. (4 min)

3rd Grade

Basic Operations & Reasoning | Intro to Multiplication

Intro to Multiplication

Follow along as students dive into the concept of multiplication. (3 min)

Equal Groups

Find the number of objects in equal groups using skip counting and repeated addition. (3 min)

Multiplication as Repeated Addition

Explore the idea of multiplication being the same as repeated addition. (3 min)

Multiplication on the Number Line

Uses a number line to represent and solve simple multiplication expressions. (4 min)

Multiplication as Equal Groups

Uses arrays and repeated addition to visualize multiplication. (3 min)

More Ways to Multiply

Use arrays and repeated addition to multiply. (5 min)

Multiplication with Arrays

Explore representing 12 with multiplication. (4 min)

Multiplication in Real World Contexts

See how to relate multiplication to real world contexts. (5 min)

Commutative Property of Multiplication

Explore what happens when we multiply numbers in different orders. (4 min)

Basic Operations & Reasoning | 1-Digit Multiplication

Distributive Property when Multiplying

Use the distributive property to break up 4×7 into smaller numbers. (6 min)

Properties and Patterns for Multiplication

Learn to change the order of numbers or decompose numbers to simplify multiplication problems. (8 min)

Basic Operations & Reasoning | Addition, Subtraction & Estimation

Rounding to the Nearest 10 on the Number Line

Learn to round numbers to the nearest ten using a number line. (9 min)

Rounding to the Nearest 100 on the Number Line

Learn to round numbers to the nearest hundreds using a number line. (7 min)

Rounding to the Nearest 10 and 100

Learn to round up to 4-digit numbers to the nearest ten and hundred. (6 min)

Estimating when Adding Multi-Digit Numbers

Learn about estimating when adding multi-digit numbers. (4 min)

Using Place Value to Add 3-Digit Numbers: Part 1

Explore adding two 3-digit numbers using place value and carrying. (2 min)

Using Place Value to Add 3-Digit Numbers: Part 2

Learn to use regrouping to add $536 + 398$. (2 min)

Adding 3-Digit Numbers

Learn to use regrouping, or carrying to add $709 + 996$, $373 + 88$, and $149 + 293$. (3 min)

Estimating when Subtracting Large Numbers

Use estimation to find reasonable solutions to 2 and 3-digit subtraction problems. (3 min)

Subtraction by Breaking Apart

Solve 2 and 3-digit subtraction problems by breaking apart the numbers by place value. (3 min)

Adding and Subtracting on a Number Line

Add and subtract numbers like 585 and 368 using a number line. (2 min)

Methods for Subtracting 3-Digit Numbers

Subtract $357 - 156$ using place value strategies. (5 min)

Worked Example: Subtracting 3-Digit Numbers

Learn to use regrouping (borrowing) and place value to subtract $971 - 659$. (3 min)

Subtracting 3-Digit Numbers (Regrouping)

Use regrouping (borrowing) and place value to subtract $629 - 172$. (3 min)

Worked Example: Subtracting 3-Digit Numbers (Regrouping Twice)

Use regrouping (borrowing) to subtract $913 - 286$. (4 min)

Worked Example: Subtracting 3-Digit Numbers (Regrouping Twice)

Learn to borrow from a 0 to subtract $301 - 164$. (4 min)

Worked Example: Subtracting 3-Digit Numbers (Regrouping from 0)

Learn to borrow from a 0 to subtract $301 - 164$. (2 min)

Missing Number for 3-Digit Addition within 1,000

Solve for the missing number in problems like $___ + 261 = 630$. (4 min)

3-Digit Addition Word Problems

Work through a word problem that involves 3-digit addition. (2 min)

3-Digit Subtraction Word Problems

Work through a word problem that involves 3-digit subtraction. (3 min)

Basic Operations & Reasoning | Intro to Division

Division as Equal Groups

Visualize division as equal groups of objects. (4 min)

Visualizing Division with Arrays

Use Arrays to represent division expression. (2 min)

Division in Context

Learn to relate division expression to real world contexts. (4 min)

Relating Division to Multiplication

Learn about the relationship between multiplication and division problems. (3 min)

Multiplication Word Problem: Parking Lot

Use a picture and repeated addition to solve a multiplication word problem. (2 min)

Division Word Problem: School Building

Use a picture and understanding of multiplication to solve a division problem. (4 min)

Basic Operations & Reasoning | More with Multiplication & Division

Unknowns with Multiplication and Division

Find the missing number in multiplication and division equations. (5 min)

Multiplication Word Problems: Soda Party

Use a picture and repeated addition to solve a multiplication word problem. (2 min)

Division Word Problems: Blueberries

Use a picture and understanding of multiplication to solve a division word problem. (4 min)

Associative Property of Multiplication

Explore the associative property of multiplication. (3 min)

Properties of Multiplication

Use pictures and practice problems to see commutativity and associativity in multiplication. (5 min)

Using Associative Property to Simplify Multiplication

Use the associative property to multiply 2-digit numbers by 1-digit numbers. (4 min)

Multiplying by Multiples of 10

Learn how to decompose multiples of ten to multiply. (3 min)

Multiplying by Tens Word Problems

Learn to multiply by 10s to solve a word problem. (3 min)

Basic Operations & Reasoning | Arithmetic Patterns & Problem Solving

Order of Operations (2-Step Expressions)

Learn to evaluate 2-step whole number expressions with different operations. (4 min)

2-Step Estimation Word Problems

Solve 2-step estimation word problems with whole numbers. (3 min)

Setting Up 2-Step Word Problems

Learn to represent 2-step word problems with equations. (2 min)

2-Step Word Problems: Truffles

Solve a two-step word problem by drawing a picture and creating an equation. (5 min)

2-Step Word Problems: Running

Solve a two-step word problem by drawing a picture and creating an equation. (3 min)

2-Step Word Problems: Theater

Solve a 2-step word problem by drawing a picture and creating an equation. (3 min)

Finding Patterns in Numbers

Learn to identify patterns in number sequences by analyzing three different sequences. (3 min)

Recognizing Number Patterns

Explore whole number patterns and their rules, including patterns in tables. (3 min)

Intro to Even and Odd Numbers

Learn the difference between even and odd numbers and how they interact when added together. (7 min)

Patterns with Multiplying Even and Odd Numbers

Explore the patterns in products when multiplying even and odd numbers. (3 min)

Patterns in Hundreds Chart

Explore patterns with the numbers in a hundreds chart. (4 min)

Patterns in Multiplication Tables

Explore the multiplication table and work to fill in missing pieces. (5 min)

Basic Operations & Reasoning | Time

Telling Time with Number Line

Use a number line to tell time and find the duration of an event. (7 min)

Telling Time to the Nearest Minute (Labeled Clock)

Learn to read the time on labeled analog clocks to the nearest minute. (4 min)

Telling Time to the Nearest Minute (Unlabeled Clock)

Learn to read the time on unlabeled analog clocks to the nearest minute. (3 min)

Time Differences Example

Learn to find the difference between the times shown on two different analog clocks. (4 min)

Time Word Problem: Travel Time

Learn to work through a word problem involving calculating. (4 min)

Time Word Problem: Puzzle

Figure out how long it took to solve a puzzle when given the start and finish time. (2 min)

Geometry | Area

Intro to Quadrilaterals

Discover attributes and features of four-sided shapes, including parallelograms, rhombuses, rectangles, and squares. (8 min)

Intro to Area and Unit Squares

Explore area by comparing two figures' space on a surface. Using unit square, learn to measure areas, (4 min)

Measuring Rectangles with Different Unit Squares

Find areas of a rectangle with different sized units. (3 min)

Creating Rectangles with a Given Area 1

Learn to create a rectangle with a given area. (3 min)

Creating Rectangles with a Given Area 2

Learn to create a rectangle that has the same area (but different side lengths) than a given rectangle. (3 min)

Counting Unit Squares to Find Area Formula

Learn to use unit squares to see why multiplying side-lengths can also find the area of rectangles. (5 min)

Transitioning from Unit Squares to Area Formula

Learn to find the area of a rectangle both by counting unit squares and multiplying side lengths. (3 min)

Finding Missing Side when Given Area

Find the missing length on a rectangle when given the area of the rectangle. (3 min)

Comparing Areas of Plots of Land

Find the area of two rectangles to solve a word problem. (3 min)

Area and the Distributive Property

Use the distributive property to find area of rectangles. (4 min)

Decomposing Shapes to Find Area: Grids

Find the area of an irregular shape by decomposing it into 2 rectangles. (3 min)

Decomposing Shapes to Find Area: Add

Find the area of an irregular 10-sided shape by breaking it into smaller rectangles. (3 min)

Decomposing Shapes to Find Area: Subtract

Find the area of an irregular shape by decomposing it into 2 rectangles and subtracting the area of the rectangles. (3 min)

Geometry | Perimeter

Perimeter: Introduction

Perimeter is a math concept that measures the total length around the outside of a shape. (3 min)

Perimeter of a Shape

Learn to find the perimeter of a shape. (2 min)

Finding Perimeter when a Side Length is Missing

Learn to find perimeter of a shape by using the clues to figure out the length of a side if it isn't labeled. (3 min)

Finding Missing Side Length when Given Perimeter

Learn to find the lengths of unknown sides on a shape by using the given perimeter and the lengths of known sides. (5 min)

Perimeter Word Problem: Tables

Solves a perimeter word problem that involves combining two perimeters. (4 min)

Perimeter Word Problem: Skating Rink

Solve a word problem involving perimeter of a rectangle. (3 min)

Comparing Areas and Perimeters of Rectangles

Compare the areas and perimeters of rectangles to a given rectangle. (5 min)

Fractions, Decimals, Percents & Ratios | Understanding Fractions

Intro to Fractions

Visualize how to divide wholes into equal-sized pieces to create unit fractions. (4 min)

Cutting Shapes into Equal Parts

Visualize and explore how cutting shapes into parts equal a fraction of the object. (2 min)

Identifying Unit Fractions Word Problem

Solve a word problem by using a unit fraction. (2 min)

Fractions in Contexts

Use fractions to represent real-world contexts. (4 min)

Identifying Numerators and Denominators

Identifying numerators and denominators in fractions. (2 min)

Recognize Fractions

Use fractions to name parts of a whole. (4 min)

Recognizing Fractions Greater than 1

Use fraction models to identify a fraction greater than 1. (1 min)

Relating Number Lines to Fraction Bars

Learn to use fraction bars to show fractions on a number line. (3 min)

Fractions on a Number Line

Explore how to represent fractions on a number line. (4 min)

Finding 1 on the Number Line

Locate 1 on a number line labeled with 0 and a unit fraction. (2 min)

Fractions Greater than 1 on the Number Line

Use a number line to plot fractions greater than 1. (3 min)

Representing 1 as a Fraction

Explore various ways to represent the number 1 as a fraction, like $1/1$, $2/2$, and $3/3$. (4 min)

Relating Fractions to 1

Use 1 as a benchmark for identifying fractions greater than or less than 1. (3 min)

Whole Numbers as Fractions

Explore how to represent whole numbers as fractions. (4 min)

Writing Whole Numbers as Fractions

Learn how to represent fractions as whole numbers and whole numbers as fractions. (2 min)

Fractions, Decimals, Percents & Ratios | Equivalent Fractions & Comparing Fractions

Comparing Fractions with $>$ and $<$ Symbols

Explore and learn how to compare fractions. (5 min)

Comparing Fractions Visually

Learn to compare fractions by graphing them a number line and drawing fraction models. (4 min)

Comparing Fractions with the Same Denominator

Learn to compare fractions with the same denominator. (3 min)

Comparing Unit Fractions

Compare fractions by visualizing them as parts of a whole. (3 min)

Comparing Fractions with the Same Numerator

Compare fractions with the same numerator visually. (4 min)

Comparing Fractions of Different Wholes: Part 1

Utilize visual fraction models to compare fractions. (5 min)

Comparing Fractions of Different Wholes: Part 2

Utilize visual fraction models to compare fractions. (3 min)

Equivalent Fractions with Visuals

Learn to use same-sized wholes to show equivalent fractions. (6 min)

Equivalent Fraction Models

Use same-sized wholes to show equivalent fractions. (4 min)

Equivalent Fractions Visually

Use number lines and fraction models to show equivalent fractions. (4 min)

Creating Equivalent Fractions

Learn about equivalent fractions. (4 min)

Measurement & Data | Measuring Mass & Volume

Understanding Mass (Grams and Kilograms)

Learn about what mass means and examine the masses of real objects. (7 min)

Word Problems with Mass

Solve word problems involving mass. (4 min)

Understanding Volume (Liters)

Learn about what volume means and examine the masses of real objects. (5 min)

Word Problems with Volume

Solve a word problem using volume. (4 min)

Measurement & Data | Represent & Interpret Data

Creating Picture and Bar Graphs

Create and interpret bar and picture graphs. (5 min)

Solving Problems with Picture Graphs

Use picture graphs to solve word problems. (4 min)

Interpreting Picture Graphs: Paint

Solve a multi-step word problem utilizing a picture graph. (2 min)

Interpreting Picture Graphs: Notebook

Solve a multi-step word problem utilizing a picture graph. (4 min)

Reading Bar Graphs: Movies

Interpret bar graphs to answer questions about a context. (4 min)

Interpreting Bar Graphs: Colors

Solve a multi-step word problem using a bar graph. (4 min)

3.MD.4 | Measuring Lengths to the Nearest $\frac{1}{4}$ Unit

Use a ruler to measure lengths to the nearest $\frac{1}{4}$ unit. (2 min)

Graphing Data on Line Plots

Learn about measurements on line plots, also called dot plots. (5 min)

Interpreting Line Plots with Fractions

Interpret data on line plots to the nearest $\frac{1}{4}$ unit with some unlabeled tick marks. (4 min)

4th Grade

Basic Operations & Reasoning | Place Value

Place Value Blocks

Identify numbers represented by place value blocks. (6 min)

Place Value Tables

Learn about how to use a place value table to break up a number. (2 min)

Finding Place Value

Find the place value of 3 in 4356. (2 min)

Creating the Largest Number

Learn how to arrange digits to make the largest possible number. (2 min)

Writing a Number in Expanded Form

Learn to write 14,897 in expanded form. (5 min)

Writing Numbers in Words and Standard Form

Write whole numbers in words and write numbers in word form and standard form. (5 min)

Regrouping Whole Number Place Values

Learn to regroup whole numbers by their place values. (6 min)

Regrouping Numbers into Various Place Values

Visualize different ways to regroup 4500. (2 min)

Adding Whole Numbers by Their Place Values

Learn to add numbers like 19 thousands + 7 tens by thinking about their place values. (6 min)

Multiplying Whole Numbers by 10

Visualize a pattern from multiplying whole numbers by 10. (7 min)

Dividing Whole Numbers by 10

Visualize a pattern from dividing whole numbers by 10. (7 min)

Understanding Place

Learn how a digit in one place represents ten times what it represents in the place to its right. (3 min)

Place Value when Multiplying and Dividing by 10

Learn how multiplying and dividing by 10 affects place value. (5 min)

Comparing Multi-Digit Numbers

Learn to compare multi-digit numbers such as 350,000 and 53,000. (6 min)

Comparing Whole Number Place Values

Learn to compare whole numbers written in expanded form, written form, and number form. (2 min)

Basic Operations & Reasoning | Addition, Subtraction, & Estimation

Rounding Whole Numbers to Nearest Hundred

Learn to round 24,259 to the nearest hundred. (4 min)

Rounding Whole Numbers to Nearest Thousand

Learn to round 423,275 to the nearest Thousand. (2 min)

Rounding Whole Numbers: Missing Digit

Find the missing digit in an estimation problem by using a number line. (6 min)

Rounding Whole Numbers Word Problems

Solve word problem by rounding whole numbers to the nearest ten, hundred, or thousand. (3 min)

Relate Place Value to Standard Algorithm for Multi-Digit Addition

Learn to transition from a place value chart to standard algorithm when adding multi-digit numbers. (6 min)

Adding Multi-Digit Numbers:

48,029+233,930

Learn to add 48,029+233,930 using the standard algorithm. (2 min)

Relate Place Value to Standard Algorithm for Multi-Digit Subtraction

Learn to transition from a place value chart to standard algorithm when subtracting multi-digit numbers. (6 min)

Multi-Digit Subtraction: 389,002-76,151

Learn to subtract 389,002-76,151 using the standard algorithm. (3 min)

Basic Operations & Reasoning | Multiply by 1-Digit Numbers

Comparing with Multiplication

Learn to represent multiplication equations as comparisons. (3 min)

Comparing with Multiplication and Addition: Giraffe

Learn to solve two multiplication comparison word problems. (5 min)

Comparing with Multiplication and Addition: Money

Learn to solve two multiplication comparison word problems. (7 min)

Comparing with Multiplication: Magic

Solve a multiplication comparison word problem with Harry Potter characters. (1 min)

Multiplying 1-Digit Numbers by 10, 100, and 1000

Learn to find a pattern from multiplying 1-digit numbers by 10, 100, and 1000. (6 min)

Multiplying 1-Digit Numbers by Multiples of 10, 100, and 1000

Learn to find a pattern from multiplying 1-digit numbers by multiples of 10, 100, and 1000. (8 min)

Using Area Model and Properties to Multiply

Learn to use place value, the distributive property, associative property, and an area model to show more ways to multiply. (6 min)

Estimating with Multiplication

Learn to use an area model to multiply 6×7981 . (3 min)

Multiplying 2-Digits by 1-Digit with Partial Products

Learn to estimate to find reasonable products to 1-digit by 2, 3, and 4-digit multiplication expressions. (4 min)

Multiplying 3-Digit by 1-Digit

Learn to multiply a 3-digit number by a 1-digit number without regrouping. (2 min)

Multiplying 3-Digit by 1-Digit (Regrouping)

Learn to multiply a 3-digit number by a 1-digit number using regrouping. (2 min)

Basic Operations & Reasoning | Multiply by 2-Digit Numbers

Multiplying 10s

Learn to multiply multiples of 10 by other multiples of 10, such as 30×50 . (5 min)

Multiplying with Area Model: 16×27

Learn to use an area model to multiply 16×27 . (9 min)

Multiplying with Area Model: 78×65

Learn to use an area model to multiply 78×65 . (5 min)

Estimating 2-Digit Multiplication

Learn to estimate to find reasonable products to 2-digit multiplication expressions. (3 min)

Multiplying Two 2-digit Numbers Using Partial Products

Learn to use the distributive property to find each part of the product to get the whole product. (5 min)

Multiplying 2-Digit Numbers

Learn to multiply 2-digit numbers. (4 min)

Basic Operations & Reasoning | Division

Estimating Division that Results in Non-Whole Numbers

Use estimation to find quotients that are non-whole numbers. (4 min)

Introduction to Remainders

Visualize and learn how a remainder is what's left over in a division problem. (5 min)

Quotients that are Multiples of 10

Visualize how to break down division problems using multiples of 10. (6 min)

Division Using Place Value

Learn to use an understanding of place value to divide $5600 \div 8$ and $846 \div 2$. (8 min)

Division with Area Models

Use area models to divide $268 \div 2$ and $856 \div 8$. (8 min)

Estimating Quotients

Solve using estimation to determine if quotients are reasonable or unreasonable. (4 min)

Introduction to Division with Partial Quotients (No Remainder)

Learn to divide multi-digit numbers by a single-digit numbers using partial quotients. (6 min)

Division with Partial Quotients (Remainder)

Learn to divide multi-digit numbers by single-digit numbers using partial quotients. (7 min)

Intro to Long Division (No Remainders)

Visualize how to do long division with the problem $96 \div 4$. (3 min)

Division Word Problem: Field Goals

Work to solve a division word problem involving field goals. (3 min)

Multiplication Word Problem: Pizza

Work to solve a multiplication word problem about pizza. (3 min)

2-Step Estimation Word Problem

Learn to use estimation to solve multi-step word problems involving addition, subtraction, multiplication, and division. (3 min)

Basic Operations & Reasoning | Factors, Multiples, & Patterns

Understanding Factor Pairs

Use multiplication and an understanding of area to identify factor pairs for 6 and 16. (4 min)

Finding Factors of a Number

Identify the factors of 120. (10 min)

Reasoning about Factors and Multiples

Use the equation $3 \times 5 = 15$ to understand the relationship between factors and multiples. (2 min)

Finding Factors and Multiples

Use divisibility rules to determine if numbers are factors of 154 and then find multiples of 14. (4 min)

Identifying Multiples

Use skip counting and division to identify multiples of 9. (4 min)

Prime Numbers

Identify that prime numbers are numbers that have only 2 factors: 1 and themselves. (8 min)

Recognizing Prime and Composite Numbers

Learn to recognize prime numbers in a group of numbers and if it is prime, composite or neither. (5 min)

Factors and Multiples: Days of the Week

Learn to use factors and multiples to figure out days of the week. (5 min)

Math Patterns: Table

Visualize and identify a pattern with the number of seats at a table. (4 min)

Math Patterns: Toothpicks

Visualize and explore a pattern of creating figures with toothpicks. (6 min)

Geometry | Plane Figures

Terms & Labels in Geometry

Explore geometry fundamentals, including points, line segments, rays, and lines. (13 min)

Lines, Line Segments, & Rays

Learn the difference between lines, line segments, and rays. (3 min)

Angles: Introduction

Learn about angles and the parts of an angle, like the vertex. (7 min)

Naming Angles

Learn to name angles based on their vertex and endpoints. (2 min)

Identifying an Angle

Identify pictures of angles to their degrees. (2 min)

Acute, Right, & Obtuse Angles

Learn about angle types and see examples of each. (5 min)

Recognizing Angles

Identify acute, obtuse, and right angles in diagrams and pictures. (2 min)

Drawing Acute, Right and Obtuse Angles

Learn how to draw acute, right, and obtuse angles with given points. (3 min)

Parallel & Perpendicular Lines Intro

Learn how to identify parallel and perpendicular lines. (2 min)

Parallel & Perpendicular Lines

Learn to identify parallel lines and perpendicular lines. (3 min)

Drawing Parallel Line Segments

Use given points to draw parallel line segments. (2 min)

Classifying Triangles

Explore how triangles are classified based on their sides and angles. (6 min)

Classifying Triangles by Angles

Learn how to categorize a triangle by its angles vs. the length of the sides. (6 min)

Worked Example: Classifying Triangles

Work through sample problems categorizing triangles as scalene, isosceles, equilateral, acute, right, or obtuse. (2 min)

Classifying Shapes by Line and Angle Types

Learn to categorize shapes based on their sides and angles. (2 min)

Quadrilateral Properties

Learn about the properties of quadrilaterals, parallelograms, trapezoids, rhombuses, rectangles, and squares. (5 min)

Classifying Shapes by Lines and Angles

Learn to classify a shape based on hints about its sides and angles. (4 min)

Intro to Reflective Symmetry

Introduction to the concept of an "axis of symmetry". (3 min)

Identifying Symmetrical Figures

Learn to identify lines of symmetry on three shapes. (6 min)

Geometry | Measuring Angles

Angle Measurement & Circle Arcs

Learn to measure angles as part of a circle. (8 min)

Measuring Angles with a Circular Protractor

Use a circular protractor to measure angles. (2 min)

Angles in Circles Word Problem

Solve word problems about angles as part of a circle. (3 min)

Measuring Angles in Degrees

Learn how to measure an angle with a protractor. (8 min)

Measuring Angles Using a Protractor

Learn to use a virtual protractor to measure angles. (3 min)

Measuring Angles Using a Protractor 2

Use a protractor to measure several angles. (4 min)

Constructing Angles

Use a protractor to create 10° and 155° angles. (3 min)

Decomposing an Angle

Find the measure of angles by adding or subtracting. (2 min)

Decomposing Angles

Find the measure of angles using addition. (3 min)

Geometry | Area & Perimeter

Area & Perimeter Word Problem: Dog Pen

Figure out the width of a dog pen in this word problem. (3 min)

Area & Perimeter Word Problem: Table

Solve this word problem and find the dimension of a table. (5 min)

Comparing Areas Word Problem

Compare the area of two posters using their side-lengths. (3 min)

Fractions, Decimals, Percents, & Ratios | Equivalent Fractions & Comparing Fractions

Equivalent Fractions with Models

Learn to use fraction models and tape diagrams to help identify equivalent fractions. (6 min)

Equivalent Fractions on Number Lines

Learn to use a number line to help identify equivalent fractions with different denominators. (5 min)

Equivalent Fractions

Learn how equivalent fractions represent the same amount, even with different numerators and denominators. (4 min)

More on Equivalent Fractions

Learn to use fraction models and multiplication to find equivalent fractions. (5 min)

Equivalent Fractions and Different Wholes

Visualize that two fractions are equivalent only if they refer to the same whole. (6 min)

Comparing Fractions of Different Wholes

Learn to compare fractions of different wholes. (5 min)

Finding Common Denominators

Learn how to use the least common multiple of the denominators to rewrite fractions, making them easier to compare or add. (5 min)

Common Denominators: $\frac{1}{4}$ and $\frac{5}{6}$

Learn how to find common denominators for fractions with different numerators and denominators by identifying multiples of the original denominators. (8 min)

Common Denominators: $\frac{3}{5}$ and $\frac{7}{2}$

Visualize how to rewrite fractions with different denominators as equivalent fractions with a common denominator. (4 min)

Comparing Fractions: Tape Diagram

Learn to compare fractions with unlike denominators by drawing bars. (2 min)

Comparing Fractions: Number Line

Learn to compare fractions on a number line. (3 min)

Comparing Fractions: Fraction Models

Learn to compare fractions visually with pies. (3 min)

Comparing Fractions 1

(Unlike Denominators)

Learn to compare fractions by finding a common denominator. (4 min)

Comparing Fractions Word Problems

Work to compare fractions using real-world contexts. (5 min)

Fractions, Decimals, Percents, & Ratios | Add & Subtract Fractions

Decomposing a Fraction Visually

Use a tape diagram to decompose $\frac{7}{9}$. (5 min)

Decomposing a Mixed Number

Use fraction models to decompose $2\frac{1}{4}$. (5 min)

Adding Fractions with Like Denominators

Learn to add $\frac{3}{15} + \frac{7}{15}$. (3 min)

Subtracting Fractions with Like

Denominators

Learn to subtract $\frac{8}{18} - \frac{5}{18}$. (3 min)

Fraction Word Problem: Piano

Solve a fraction word problem about practicing piano. (3 min)

Fraction Word Problem: Pizza

Solve a fraction model to figure out what fraction of a pizza is left. (5 min)

Fraction Word Problem: Spider Eyes

Solve a fraction word problem about spider eyes. (2 min)

Writing Mixed Numbers as Improper Fractions

Visualize how to rewrite $5\frac{1}{4}$ as an improper fraction. (7 min)

Writing Improper Fractions as Mixed Numbers

Visualize how to rewrite $\frac{7}{4}$ as a mixed number. (4 min)

Adding Mixed Numbers with Like Denominators

Visualize adding mixed numbers with common (like) denominators. (3 min)

Subtracting Mixed Numbers with Like Denominators

Visualize subtracting mixed numbers with common (like) denominators. (2 min)

Mixed Number Addition with Regrouping

Learn to use regrouping to add mixed numbers with common (like) denominators. (4 min)

Subtracting Mixed Numbers with Regrouping

Learn to use regrouping to subtract mixed numbers with common (like) denominators. (3 min)

Fraction Word Problem: Lizard

Solve a fraction word problem about the length of a lizard. (2 min)

Subtracting Mixed Numbers with Like Denominators Word Problem

Solve a word problem involving mixed number subtraction by using a visual model. (3 min)

Visually Converting Tenths and Hundredths

Learn to rewrite $\frac{8}{10}$ with a denominator of 100. (4 min)

Decomposing Hundredths

Learn to decompose $\frac{47}{100}$ into tenths and hundredths. (4 min)

Decomposing Hundredths on Number Line

Visualize how to decompose $\frac{26}{100}$ into tenths and hundredths using a number line. (2 min)

Adding Fractions (Denominators 10 & 100)

Learn to add $\frac{3}{10} + \frac{7}{100}$ by finding a common denominator. (5 min)

Adding Fractions: $\frac{7}{10} + \frac{13}{100}$

Use visual models to add $\frac{7}{10}$ and $\frac{13}{100}$. (3 min)

Making Line Plots with Fractional Data

Use a line plot to represent data sets. (3 min)

Interpreting Line Plots with Fractions

Use a Line plot to visualize the difference between two numbers. (3 min)

Reading a Line Plot with Fractions

Explore the concept of interpreting data on line plots, particularly focusing on how to read and understand line plots that display measurements in fractions. (3 min)

Fractions, Decimals, Percents, & Ratios | Multiply Fractions**Multiplying Fractions and Whole Numbers Visually**

Visually represents this process and practices understanding the relationship between fractions and whole numbers in multiplication. (4 min)

Fraction Multiplication on the Number Line

Use number lines to help solve multiplication equations. (3 min)

Equivalent Fractions and Whole Number Multiplication Problems

Learn to relate mixed numbers to whole number/fraction multiplication problem. (3 min)

Multiplying Unit Fractions and Whole Numbers

Learn how to multiply a whole number by a fraction, using both visual and computational methods. (3 min)

Multiplying Mixed Numbers by Whole Numbers

Use repeated addition to help multiply a whole number by a mixed number. (3 min)

Multiplying Fractions Word Problem: Milk

Solve a multiplication Fraction Word Problem about Milk. (2 min)

Multiplying Fractions Word Problem: Movies

Solve a multiplication fraction word problem about movies. (4 min)

Multiplying Fractions by Whole Numbers Word Problem

Solve a word problem that involves multiplying a fraction by a whole number. (3 min)

Fractions, Decimals, Percents, & Ratios | Understanding Decimals**Writing a Number as a Fraction and Decimal**

Show the connection between decimals and fractions using a grid diagram and number lines. (4 min)

Writing Decimals and Fractions Greater than 1 Shown on Grids

Learn to decimal numbers and fractions greater than 1 shown on grids. (3 min)

Writing Decimals and Fractions Shown on Number Lines

Learn to write decimal numbers and fractions greater than 1 shown on number lines. (3 min)

Rewriting Fractions as Decimals

Learn to rewrite two fractions as decimals. (4 min)

Decimals as Words

Visualize how to write 0.17 and 40.03 in words. (6 min)

Relating Decimals and Fractions in Words

Learn to relate equivalent decimals and fractions written in word form. (3 min)

Decimal Place Value

Learn how decimal numbers and understanding place value to the right of the decimal. (6 min)

Graphing Tenths from 0 to 1

Visualize and learn how to graph 0.6 on a number line. (2 min)

Identifying Tenths on a Number Line

See how to identify a point graphed on a number line. (2 min)

Graphing Hundredths from 0 to 0.1

Visualize and learn how to graph 0.4 on a number line. (3 min)

Identifying Hundredths on a Number Line

Learn to identify decimals graphed on a number line. (3 min)

Plotting Decimal Numbers on a Number Line

Find decimals with hundredths on a number line. (4 min)

Decimal Place Value with Regrouping

Visualize and discuss decimal numbers that are greater than 1. (6 min)

Rewriting Decimals as Fractions: 0.8

Convert 0.8 to a fraction. (1 min)

Rewriting Decimals as Fractions: 0.15

Convert the decimals to a fraction and simplify. (2 min)

Rewriting Decimals as Fractions: 0.36

Follow this example of how we convert a decimal to a simplified fraction. (2 min)

Rewriting Decimals as Fractions: 2.75

Follow this example of how we convert a decimal to a simplified fraction. (3 min)

Common Fractions and Decimals

Explores the concept of converting common fractions ($\frac{1}{5}$, $\frac{1}{4}$, $\frac{1}{2}$) into decimals. (5 min)

Comparing Decimals Visually

Use grid diagrams to compare 0.17 and 0.2. (4 min)

Comparing Decimal Numbers on a Number Line

Use a number line to compare decimals. (2 min)

Comparing Numbers Represented Different Ways

Compare decimals, fractions and number diagrams in these practice problems. (8 min)

Comparing Decimals (Tenths and Hundredths)

Use greater and less than symbols to compare decimals. (4 min)

Measurement & Data | Units of Measurement

Metric System: Units of Weight

Identify metric units of mass or weight such as milligram, gram, and kilogram. (5 min)

Choose Pounds or Ounces to Measure Weight

Identify the US customary units of mass or weight such as ounce, pound, and ton. (2 min)

U.S. Customary Units: Weight

Identify the US customary units of mass or weight such as ounce, pound, and ton. (4 min)

Metric System: Units of Volume

Learn about metric units of volume or capacity such as milliliters and liters. (4 min)

U.S. Customary Units: Fluid Volume

Learn about the US customary units of volume or capacity such as teaspoon, fluid ounce, cup, pint, quart, and gallon. (7 min)

Metric System: Units of Distance

Discuss metric units of length or distance such as millimeter, centimeter, meter, and kilometer. (7 min)

U.S. Customary Units: Distance

Learn about the US customary units of length or distance such as inch, foot, and yard. (5 min)

Finding Reasonable Units of Measurement Example

Decide a reasonable unit of time for baking cookies. (4 min)

Time Differences Example

Learn to find the difference between the times shown on two different analog clocks. (4 min)

Time Word Problem: Puzzle

Figure out how long it took to solve a puzzle when given the start and finish time. (2 min)

Time Word Problem: Travel Time

Solve what time you leave if you are traveling 39 minutes and need to be home at 6:15. (4 min)

How to Convert kg to mg and t to oz

Convert kilograms to milligrams and tons to ounces. (4 min)

Converting Pounds to Ounces

Learn to convert pounds to ounces. (2 min)

Metric Units of Mass Review (g and kg)

Learn to convert between liters and milliliters. (2 min)

Converting US Customary Units of Volume

Learn to convert between gallons, quarts, pints, cups, and fluid ounces. (2 min)

Converting Metric Units of Length

Learn to convert kilometers, meters, and centimeters. (2 min)

Converting Feet to Inches

Learn to convert feet to inches. (1 min)

Converting Yards to Inches

Learn to convert between yards, feet, and inches. (6 min)

Converting Units of Time

Learn to convert hours, minutes, and seconds. (4 min)

Time Word Problem: Susan's Break

Solve what time do you leave if you are traveling 39 minutes and need to be home at 6:15. (4 min)

Word Problem: Making Change

Understand the importance of the relationship between these units and demonstrate how to apply this knowledge to solve real-world problems involving time intervals. (3 min)

Currency Conversion Word Problem

Solve how much change is due in this conversion word problem. (1 min)

Multi-Step Unit Conversion Examples (Metric)

Learn to convert between American dollars and Chinese yuan in this word problem. (5 min)

Multi-Step Unit Conversion Examples (U.S. Customary)

Solve multi-step unit conversion examples with metric units of measure. (5 min)

5th Grade

Basic Operations & Reasoning | Multi-Digit Multiplication & Division

Strategies for Multiplying Multiples of 10, 100 and 1,000

Learn the strategy of estimating in multi-digit multiplication. (7 min)

Estimating Multi-Digit Multiplication

Learn the skill of estimating the product of multi-digit numbers. (3 min)

Relate Multiplication with Area Models to the Standard Algorithm

Learn the concept of multi-digit multiplication. (7 min)

Intro to Standard Way of Multiplying Multi-Digit Numbers

Learn the standard algorithm for multiplying a multi digit number by a single digit number. (4 min)

Understanding the Standard Algorithm for Multiplication

Visualize the standard algorithm for multiplication in these three examples: one complete walkthrough, one where the viewer is asked to identify mistakes in incorrect solutions, and one where the viewer is asked to fill in a missing number. (5 min)

Multiplying Multi-Digit Numbers: $6,742 \times 23$

Learn to break down the process step by step, demonstrating how to multiply each digit and carry over numbers. (4 min)

Strategies for Dividing Multiples of 10, 100, and 1,000

Visualize and understand how to divide numbers that are multiples of 10, 100, and 1,000. (7 min)

Estimating Multi-Digit Division

Learn the concept of estimating multi-digit division problems. (3 min)

Long Division with Remainders: $2,292 \div 4$

Learn the long division process for multi-digit numbers, including examples with remainders. (10 min)

Long Division with Remainders: $3,771 \div 8$

Visualize and solve a long division problem with a remainder. (3 min)

Introduction to Dividing by 2-Digits

Visualize how to approximate numbers for easier division and practice this skill with examples (5 min)

Dividing by 2-Digits: $9,815 \div 65$

Learn the process of dividing large numbers, specifically 9,815 divided by 65. (5 min)

Dividing by 2-Digits: $7,182 \div 42$

Learn to break complex division problems into easy step-by-step portions. (3 min)

Dividing by a 2-Digits: $4,781 \div 32$

Learn to break complex division problems into easy step-by-step portions. (4 min)

Basic Operations & Reasoning | Powers of 10

Multiplying and Dividing by 10, 100, 1,000

Learn how multiplying and dividing whole numbers by 10, 100, and 1,000 shifts the digits of the number left or right, respectively. (9 min)

Multiplying and Dividing Decimals by 10

Explore the concept of multiplying and dividing decimals by 10, 100, and 1,000. (4 min)

Multiplying and Dividing Decimals by 10, 100, 1,000

Learn how each digit in a decimal shifts place when multiplied or divided by these powers of 10, providing a visual and intuitive understanding of the process. (5 min)

Introduction to Powers of 10

Learn about exponents and exponential notations in this intro. (4 min)

Using Exponents with Powers of 10

Explore the concept of multiplying by powers of 10. (5 min)

Multiplying and Dividing by Powers of 10

Learn about the patterns when multiplying or dividing numbers by powers of 10. (5 min)

Exponents and Powers of 10 Patterns

Visualize and demonstrate how to perform calculations involving powers of ten. (7 min)

Fractions as Division by Power of 10

Explore the concept of multiplying and dividing numbers by powers of 10. (5 min)

Comparing Decimal Place Values

Explore the concept of place value in multi-digit numbers, emphasizing how a digit's value changes based on its position. (6 min)

Geometry | Volume

Volume Intro

Learn the difference in finding volume, length, and area and how they involve measuring dimensions to quantify a certain aspect of an object or space. (8 min)

Measuring Volume with Unit Cubes

Explore the concept of volume, emphasizing that it's a measure of how much space something takes up. (2 min)

Measuring Volume as Area Times Length

Learn to calculate the volume of a rectangular prism, you can multiply the dimensions (width, depth, and height) together in any order. (8 min)

Volume of a Rectangular Prism

Learn how to calculate the volume of a box using the height, width, and depth. (2 min)

Volume in Unit Cubes by Decomposing Shape

Explore the concept of decomposing complex shapes into simpler ones to calculate volume. (3 min)

Volume Through Decomposition

Explore the concept of finding the volume of complex shapes by decomposing them into simpler, non-overlapping rectangular prisms. (4 min)

Volume Word Problem: Water Tank

Learn the concept of volume, specifically focusing on how to calculate the volume of a complex shape by subtracting the volume of an object within it from the total volume. (5 min)

Geometry | Coordinate Plane

Introduction to the Coordinate Plane

Learn how coordinates are used to locate a point on a coordinated plane. (7 min)

Coordinate Plane: Graphing Points

Visualize and learn the basics of the coordinate plane. (3 min)

Coordinate Plane Graphing Word Problem

Visualize and learn the concept of using a coordinate plane to solve real-world problems. (2 min)

Interpreting Plotted Points

Learn the concept of interpreting data points on a coordinate plane. (2 min)

Geometry | Properties of Shape

Classifying Triangles

Explore how triangles are classified based on their sides and angles. (6 min)

Classifying Triangles by Angles

Learn to classify triangles based on the angles. (6 min)

Intro to Quadrilaterals

Explore and learn the many different types of quadrilaterals. (9 min)

Quadrilateral Properties

Learn about the properties of quadrilaterals, parallelograms, trapezoids, rhombuses, rectangles, and squares. (5 min)

Kites as a Geometric Shape

Explore the world of quadrilaterals, specifically focusing on kites. (6 min)

Quadrilateral Types

Learn to identify quadrilaterals such as kites, trapezoids, parallelograms, rhombuses, rectangles, and squares by side length, presence of parallel sides, and angle type. (3 min)

Classifying Quadrilaterals

Learn the many different relationships between the types of quadrilaterals. (3 min)

Algebra | Algebraic Thinking

Constructing Numerical Expressions

Learn to use the information in each word problem to construct a numerical expression that represents the information. (2 min)

Evaluating Expressions with & without Parentheses

Explore the concept of order of operations, emphasize the importance of parentheses in mathematical expressions. (2 min)

Translating Expressions with Parentheses

Understand the importance of parentheses in expressions, and how they can change the meaning of calculations. (9 min)

Graphing Patterns on a Coordinate Plane

Learn about understanding numerical patterns. Explore how to generate a second pattern from a given one by applying a rule, in this case, multiplying by 3 and adding 1. (3 min)

Interpreting Patterns on a Coordinate Plane

Explore the concept of numerical patterns, focusing on how to generate, identify, and graph them on a coordinate plane. (4 min)

Interpreting Relationships in Ordered Pairs

Explore the concept of numerical patterns, focusing on how to generate, identify, and graph these patterns on a coordinate plane. (4 min)

Graphing Sequence Relationships

Explore the concept of numerical patterns. (3 min)

Fractions, Decimals, Percents, & Ratios | Decimal Place Value

Place Value with Decimals

Learn the relationship between place value and decimals. (4 min)

Thousandths on the Number Line

Explore the value of a point on a number line that falls between two known values, in this case 0.03 and 0.04. (2 min)

Write a Decimal in Expanded Form

Learn to break down each digit according to its place value and write it in an expanded form. (3 min)

Decimals in Written Form (Hundredths)

Learn to write a decimal in word form by writing out the whole number portion. (4 min)

Decimals in Written Form (Thousandths)

Learn how to read and write decimals in different forms, focusing on thousandths. (3 min)

Expressing Decimals in Multiple Forms

Learn to break down decimals into place values, show how to write them in expanded form, separate each decimal part, and explain how to say them in words. (4 min)

Visual Understanding of Regrouping Decimals

Explore the concept of place value in decimals, focusing on how to regroup value from one place to another. (5 min)

Regrouping with Decimals

Explore the concept of expressing decimals in different forms. (4 min)

Regrouping with Decimals: 21.3

Learn about place values, and how regrouping can change the appearance of a number, but not its value. (4 min)

Comparing Decimals: 9.97 and 9.798

Learn to compare two decimals by looking at the largest place value. (4 min)

Comparing Decimals: 156.378 and 156.348

Learn how to determine which decimal is greater by comparing each place value, starting from the left and moving right, until a difference is found. (2 min)

Ordering Decimals

Practice comparing decimals and learning how to order numbers with decimals from least to greatest. (4 min)

Ordering Decimals Through Thousandths

Learn all about comparing decimals. (3 min)

Comparing Decimals in Different Representations

Learn how to determine which of two decimals is larger by converting them into a common format. (5 min)

Comparing Decimals Word Problems

Explore the concept of comparing decimals. Learn the importance of aligning place values and starting from the largest place value. (4 min)

Rounding Decimals on the Number Line

Learn how to round decimals using a number line, visually showing which whole number, tenth, hundredth, or thousandth is closest. (4 min)

Worked Example: Rounding Decimals to Nearest Tenth

Visualize how to round decimals and identify the tenth place in each decimal. (2 min)

Rounding Decimals Word Problems

Explore how to adjust decimals to the closest tenth, hundredth, and whole number, all while highlighting the importance of grasping place value. (5 min)

Fractions, Decimals, Percents, & Ratios | Add Decimals

Common Fractions and Decimals

Explores the concept of converting common fractions ($\frac{1}{5}$, $\frac{1}{4}$, $\frac{1}{2}$) into decimals. (5 min)

Estimating Decimal Addition

Learn all about how to estimate when adding decimals. (4 min)

Introduction to Adding Decimals: Tenths

Learn how to visualize and calculate the addition of tenths using both numerical and visual methods, reinforcing the understanding of decimal addition. (6 min)

Adding Decimals with Ones and Tenths Parts

Learn how to add decimals, specifically to the tenths. (6 min)

Adding Decimals with Ones, Tenths, and Hundredths

Learn about aligning decimal points and adding each place value separately, from hundredths to ones. (7 min)

Adding Decimals with Hundredths

Learn the different ways to add decimals involving hundredths. (7 min)

Fractions, Decimals, Percents, & Ratios | Subtract Decimals

Estimating Decimal Subtraction

Learn to estimate when subtracting decimals. (4 min)

Strategies for Subtracting Basic Decimals

Explore the world of subtracting decimals, focusing on tenths. (6 min)

Strategies for Subtracting more Complex Decimals with Tenths

Learn all about subtraction of decimals, particularly those in the tenths place. (9 min)

Subtracting Decimals: 9.57-8.09

Visualize how to find the least common denominator of two fractions. (1 min)

Subtracting Decimals: 10.1-3.93

Learn how to subtract decimals down to the hundredth place. (2 min)

Subtraction Strategies with Hundredths

Learn about different strategies for subtraction, breaking down the process into manageable steps, and emphasizes the importance of understanding the concept behind the calculations. (6 min)

More Advanced Subtraction Strategies with Hundredths

Explore the concept of subtracting decimals, specifically hundredths. (5 min)

Fractions, Decimals, Percents, & Ratios | Add & Subtract Fractions

Visually Adding Fractions: $5/6 + 1/4$

Learn to add two fractions with different denominators, you need to find the least common multiple of the denominators. (6 min)

Visually Subtracting Fractions: $3/4 - 5/8$

Learn about understanding how to add and subtract fractions with unlike denominators. (4 min)

Estimating Adding Fractions with Unlike Denominators

Learn all about estimating the sum of fractions with unlike denominators. (5 min)

Finding Common Denominators

Learn all about finding common denominators in fractions. (5 min)

Common Denominators: $1/4$ and $5/6$

Learn how to find common denominators for fractions with different numerators and denominators by identifying multiples of the original denominators. (8 min)

Common Denominators: $3/5$ and $7/2$

Learn how to rewrite fractions with different denominators as equivalent fractions with a common denominator. (4 min)

Adding Fractions with Unlike

Denominators Intro

Learn to add fractions with different denominators, such as $1/2$ and $1/3$, you need to find a common denominator. (4 min)

Adding Fractions with Unlike

Denominators

Learn how to add two fractions with different denominators. (8 min)

Subtracting Fractions with Unlike

Denominators Intro

Learn how to subtract fractions with unlike denominators. (4 min)

Subtracting Fractions with Unlike

Denominators

Learn to identify the least common multiple of the two denominators when subtracting fractions with different denominators. (5 min)

Adding and Subtracting 3 Fractions

Learn how to add and subtract fractions with unlike denominators. (5 min)

Solving for the Missing Fraction

Learn how to add and subtract fractions with unlike denominators. (6 min)

Adding Mixed Numbers: $19 \frac{3}{18} + 18 \frac{2}{3}$

Visualize how to add mixed numbers and simplify the fraction. (2 min)

Subtracting Mixed Numbers: $7 \frac{6}{9} - 3 \frac{2}{5}$

Visualize how to subtract two mixed numbers by converting them to improper fractions. (2 min)

Adding Mixed Numbers with Regrouping

Learn how to add mixed numbers with unlike denominators. (5 min)

Subtracting Mixed Numbers with Regrouping (Unlike Denominators)

Learn how to subtract mixed numbers with unlike denominators. (4 min)

Adding Fractions Word Problem: Paint

Learn how to add and subtract fractions with unlike denominators through a real-world problem. (6 min)

Subtracting Fractions Word Problem: Tomatoes

Learn how to solve word problems involving the addition and subtraction of fractions with unlike denominators. (4 min)

Fractions, Decimals, Percents, & Ratios | Multiply Fractions

Multiplication as Scaling with Fractions

Visualize and understand how multiplying fractions can be seen as scaling, or resizing, the value of a number. (5 min)

Fraction Multiplication as Scaling

Examples

Visualize examples of how multiplying by a fraction scales a number up or down. (4 min)

Multiplying Fractions by Whole Numbers on a Number Line

Learn to multiply fractions by whole numbers on the number line. (2 min)

Multiplying Unit Fractions and Whole Numbers

Learn how to multiply a whole number by a fraction, using both visual and computational methods. (3 min)

Multiplying Fractions and Whole Numbers Visually

Learn the concept of multiplying fractions and whole numbers. (4 min)

Multiplying Fractions and Whole Numbers

Learn and visualize how to multiply fractions and how they combine into parts of a whole. (3 min)

Multiplying 2 Fractions: Fraction Model

Visualize multiplying fractions using fraction models. (5 min)

Multiplying 2 Fractions: Number Line

Visualize how the process of multiplying fractions by fraction is represented on a number line. (5 min)

Multiplying 2 Fractions: $5/6 \times 2/3$

Work through multiplying 2 fractions with different denominators. (3 min)

Multiplying Mixed Numbers

Follow along and visualize how to multiply mixed numbers. (4 min)

Finding Area with Fractional Sides 1

Learn how to calculate the area of rectangles with fractional side lengths. (4 min)

Finding Area with Fractional Sides 2

Learn how to calculate the area of rectangles with fractional side lengths. (7 min)

Multiplying Fractions Word Problem: Muffins

Learn how to solve word problems involving the multiplication of fractions. (4 min)

Multiplying Fractions Word Problem: Laundry

Learn how to solve word problems involving multiplication of fractions. (2 min)

Multiplying Fractions Word Problem: Bike

Learn how to multiply fractions and mixed numbers. (4 min)

Fractions, Decimals, Percents, & Ratios | Divide Fractions

Understanding Fractions as Division

Learn about the relationship between multiplication and division. (7 min)

Creating a Fraction Through Division

Learn about the relationship between division and multiplication using fractions. (3 min)

Creating Mixed Numbers with Fraction Division

Learn how to interpret fractions as division problems. (5 min)

Multiplication and Division Relationship for Fractions

Learn how multiplication and division are related, even when we're dealing with fractions. (4 min)

Visually Dividing Unit Fraction by a Whole Number

Learn how to divide fractions by whole numbers. (3 min)

Dividing a Unit Fraction by a Whole Number

Learn how to divide fractions by whole numbers. (3 min)

Visually Dividing Whole Numbers by Unit Fractions

Learn how to divide whole numbers by fractions. (3 min)

Dividing a Whole Number by a Unit Fraction

Learn how to divide a whole number by a fraction. (2 min)

Fraction Division in Context

Practice dividing a fraction by a whole number to solve problems. (3 min)

Dividing Fractions and Whole Number Word Problems

Use tape diagrams to visually represent division with fractions. (5 min)

Fractions, Decimals, Percents, & Ratios | Multiply Decimals

Estimating with Multiplying Decimals and Whole Numbers

Learn all about the concept of estimating products in multiplication problems involving decimals and whole numbers. (3 min)

Multiplying Decimals and Whole Numbers with Visuals

Demonstrate how to use a number line or model to visualize the process of multiplication and find the product. (4 min)

Strategies for Multiplying Decimals and Whole Numbers

Use different methods for multiplying whole numbers with decimals. (7 min)

Strategies for Multiplying Multi-Digit Decimals by Whole Numbers

Learn how to multiply decimals and whole numbers. (4 min)

Estimating Decimal Multiplication

Use estimation to simplify the process of multiplying decimals. (4 min)

Developing Strategies for Multiplying Decimals

Learn how to multiply decimals, specifically focusing on the strategy of converting decimals to fractions to make the multiplication process easier. (5 min)

Understanding Decimal Multiplication

Learn how to use a hundred grid to represent decimal multiplication. (3 min)

Multiplying Decimals Using Estimation

Learn all about multiplying decimals by using estimation. (4 min)

Developing Strategies for Multiplying 2-Digit Decimals

Learn to multiply decimals by treating them as fractions. (4 min)

Fractions, Decimals, Percents, & Ratios | Divide Decimals

Estimating Decimal Division

Practice rounding decimals to the nearest whole number or a simple fraction, then perform the division. (3 min)

Divide Whole Numbers with Decimal Quotients: $5 \div 2$

Learn how to divide whole numbers to get a decimal quotient. (3 min)

Divide Whole Numbers with Decimal Quotients: $78 \div 12$

Learn how to break down division problems by finding multiples and using remainders. (4 min)

Dividing a Decimal by a Whole Number with Fraction Models

Visualize the concept of dividing decimals by whole numbers using the idea of converting tenths to hundredths to make division more intuitive. (2 min)

Dividing a Decimal by a Whole Number on the Number Line

Visualize the concept of dividing decimals by whole numbers, emphasize understanding division as splitting a quantity into equal parts and use the number line as a visual tool. (2 min)

Dividing a Decimal by a Whole Number Example

Follow this example of how to divide a decimal by a whole number. (3 min)

Visually Dividing a Whole Number by a Decimal

Understand how to divide whole numbers by decimals. (3 min)

Dividing a Whole Number by a Decimal on a Number Line

Explore the concept of dividing whole numbers by decimals on a number line. (2 min)

Division Strategies for Decimal Quotients

Different examples demonstrate how to use fractions, tenths, and reciprocals to multiply instead of divide so we can arrive at the correct answer. (9 min)

Pattern when Dividing by Tenths and Hundredths

Use the strategy of converting whole numbers to tenths or hundredths to make the process clearer when dividing whole numbers by decimals. (5 min)

Dividing Whole Numbers by Decimals Examples

Learn two techniques to divide whole numbers by decimals. (5 min)

Measurement & Data | Converting Units of Measure

Converting Units: Minutes to Hours

Learn how to convert minutes to hours by dividing the minutes by 60. (5 min)

Converting Units: Metric Distance

Learn all about converting different metric units to a common unit, in this case, meters. (4 min)

Converting Units: Centimeters to Meters

Learn how to convert centimeters to meters by understanding the meaning of the "centi" prefix, which represents $1/100$. (3 min)

U.S. Customary and Metric Units

Learn the world of measurement units, distinguishing between U.S. customary units and metric units. (5 min)

Measurement Word Problem:

Tea Party

Explore the concept of converting metric units within a real-world context. (4 min)

Time Word Problem: Susan's Break

Explore the concept of converting units of time, specifically minutes, into hours. (4 min)

Converting Units: US Volume

Learn how to convert US Customary units of volume (gallons, quarts, pints, and cups). (5 min)

Same Length in Different Units

Explore the concept of converting US customary units, specifically yards to inches. (6 min)

Measurement Word Problem: Running Laps

Understand how to convert units within the US customary system to solve word problems. (8 min)

Measurement Word Problem: Elevator

Learn the concept of converting units within the U.S. customary system. (7 min)

Measurement Word Problem: Blood Drive

Explore the concept of converting units within the US customary system. (4 min)

Measurement Word Problem: Distance Home

Explore the concept of converting units within the US customary system, specifically focusing on how to apply this skill to solve multi-step, real-world problems. (4 min)

Measurement & Data | Line Plots

Making Line Plots with Fractional Data

Learn about creating line plots to represent data sets. (3 min)

Interpreting Line Plots with Fractions

Use a line plot to find the difference between the two heaviest babies. (3 min)

Reading a Line Plot with Fractions

Explore the concept of interpreting data on line plots, particularly focusing on how to read and understand line plots that display measurements in fractions. (3 min)

Line Plot Distribution: Trail Mix

Explore how to interpret data on line plots, specifically focusing on measurements in fractions of a unit. (3 min)

6th Grade

Basic Operations & Reasoning | Exponents & Order of Operations

Intro to Exponents

Learn about exponents and how they represent repeated multiplication. (3 min)

The Zeroth Power

Consider two different ways to think about why a number raised to the zero power equals one. (4 min)

Exponents of Decimals

Explore that exponents of decimals can be calculated by multiplying the decimal number by itself as many times as the exponent indicates. (3 min)

Powers of Fractions

Explore how to raise fractions to a power. (2 min)

Order of Operations Introduction

Learn to follow PEMDAS (Parentheses, Exponents, Multiplication and Division, and Addition and Subtraction) to accurately evaluate expressions and avoid common mistakes. (5 min)

Worked Example: Order of Operations (PEMDAS)

Learn to follow PEMDAS to simplify and accurately solve mathematical expressions, ensuring a correct final answer. (5 min)

Order of Operations Examples: Exponents

Understanding the impact of parentheses on calculations helps avoid common mistakes and enhances problem-solving skills (4 min)

Comparing Exponent Expressions

Evaluate the expressions: 2 cubed minus 2, 2 squared plus 3 to the power of 0, and 3 squared. (2 min)

Order of Operations Example: Fractions and Exponents

Follow the order of operations to simplify expressions and find the correct answer. (4 min)

Basic Operations & Reasoning | Negative Numbers

Introduction to Negative Numbers

Explore negative numbers and see them visualized on a number line. (3 min)

Negative Symbol as Opposite

Learn about opposites in math and how they relate to negative numbers. (5 min)

Number Opposites

Explore how opposite of a positive number is its negative counterpart, while the opposite of a negative number is its positive counterpart. (3 min)

Negative Decimals on the Number Line

Learn to locate negative decimals on a number line. (1 min)

Decimals & Fractions on the Number Line

Explore how to plot numbers on a number line and visualize numerical values. (2 min)

Compare Rational Numbers Using a Number Line

Learn to compare positive and negative numbers, decimals, and fractions using a number line. (6 min)

Numerical Inequality Word Problems

Learn to compare quantities using inequalities. (3 min)

Ordering Negative Numbers

Visualize ordering negative numbers on a number line helps clarify their positions, with the least number on the left and the greatest on the right. (3 min)

Ordering Rational Numbers

Learn how to order numbers from least to greatest using a number line. (4 min)

Absolute Value Examples

Visualize how absolute value of a number represents its distance from zero on a number line, always resulting in a positive value. (2 min)

Meaning of Absolute Value

Learn how absolute value is a fundamental math concept that measures the distance of a number from zero, regardless of its sign. (4 min)

Comparing Absolute Values on the Number Line

Explore absolute values and inequalities using a number line with three numbers: a , b , and c . (4 min)

Placing Absolute Values on the Number Line

Learn and practice how to sort values from least to greatest using a number line. (2 min)

Comparing Absolute Values

Compare absolute values to determine which number is further from zero, regardless of its positive or negative sign. (4 min)

Testing Solutions to Absolute Value Inequalities

Learn how to determine if given values of x satisfy various absolute value inequalities. (6 min)

Interpreting Absolute Value

Solve this weight change scenario by plotting the changes on a number line to determine who lost the most weight. (4 min)

Geometry | Plane Figures

Area of a Parallelogram

Explore how to calculate the area of a parallelogram. (3 min)

Finding Height of a Parallelogram

Learn that the area of a parallelogram equals the base times the height. (2 min)

Area of a Triangle

Learn how to find the area of a rectangle and a parallelogram is found by multiplying the base by the height. (6 min)

Finding Area of Triangles

Learn to find the area of a triangle is found by multiplying one half of the base by the height. (2 min)

Triangle Missing Side Example

Learn how to find a missing piece of a triangle using just the area and height. (3 min)

Finding Area by Rearranging Parts

Explore Learn how to find a missing piece using just the area and height. (4 min)

Area of Composite Shapes

Determine the area of two triangles, a rectangle, and a trapezoid, and then add up the areas of the four shapes to get the total area. (5 min)

Area of Quadrilateral with 2 Parallel Sides

Learn how to find the area of a quadrilateral by splitting it into two triangles. (4 min)

Geometry | Coordinate Plane

Points on the Coordinate Plane Examples

Learn to use the coordinate plane to graph points, lines, and more. (7 min)

Plotting a Point (Ordered Pair)

Explore how to plot ordered pairs on a coordinated plane. (2 min)

Finding the Point not Graphed

Learn to spot the missing point on a graph by comparing coordinate pairs to points. (1 min)

Quadrants of the Coordinate Plane

Explore the coordinate plane and learn how it's divided into four sections, called quadrants, which quadrants are positive, and which are negative. (3 min)

Points and Quadrants Example

Explore how plotting points on a graph involves moving along the x and y axes. (2 min)

Coordinate Plane Word Problem Examples

Explore how to calculate the distance between two points, using the x and y coordinates. (5 min)

Drawing a Quadrilateral on the Coordinate Plane Example

Explore how to make a four-sided shape called a quadrilateral using line segments on a coordinated plane. (2 min)

Area of a Parallelogram on the Coordinate Plane

Find the area of a parallelogram by multiplying the base by the height. (2 min)

Coordinates of a Missing Vertex

Explore how to find the vertices of a rectangle when you are given three of them. (3 min)

Example of Shapes on a Coordinate Plane

Visualize drawing a rectangle on a coordinate plane and then finds its height. (2 min)

Dimensions of a Rectangle from Coordinates

Explore how to determine the length of a side of a rectangle given the coordinates of its vertices. (4 min)

Coordinates of Rectangle Example

Solve a challenging problem involving a quadrilateral on the coordinate plane. (2 min)

Parallelogram on the Coordinate Plane

Graph the given coordinates of three of the polygon vertices and find where the 4th vertex is. (5 min)

Geometry | 3D Figures

Counting Faces and Edges of 3D Shapes

Identify the faces and edges on various 3D shapes. (4 min)

Recognizing Common 3D Shapes

Identify the following 3D shapes: square pyramid, rectangular prism, triangular prism, cylinder, and cone. (3 min)

Volume with Fractional Cubes

Explore another way of finding the volume of a rectangular prism involves dividing it into fractional cubes, finding the volume of one, and then multiplying that volume by the number of cubes that fit into our rectangular prism (4 min)

Volume of a Rectangular Prism: Fractional Dimensions

Learn how to find the volume of a rectangular prism that has fractional side lengths. (4 min)

How Volume Changes from Changing Dimensions

Explore and discuss changing dimensions on a rectangular prism affects its volume. (4 min)

Volume of a Rectangular Prism: Word Problem

Explore how to find the volume of a rectangular prism fish tank that has fractional side lengths. (6 min)

Intro to Nets of Polyhedra

Explore how nets of polyhedra are just 2D objects that wrap around 3D objects, like wrapping paper around presents. (7 min)

Surface Area Using a Net: Triangular Prism

Learn the steps to compute the surface area of a triangular prism (3 min)

Surface Area Using a Net: Rectangular Prism

Learn whether a certain net could be folded up into a certain rectangular prism. (4 min)

Surface Area of a Box (Cuboid)

Learn how to find the surface area of a cuboid which has 6 rectangular faces, add the areas of all 6 faces. (3 min)

Surface Area of a Box Using Nets

Learn how to find the surface area of cereal box using nets. (5 min)

Surface Area Word Problem Example

Solve a word problem that involves the surface area of a square pyramid. (5 min)

Algebra | Variables & Expressions

What is a Variable?

Explore and learn how variables are symbols, often letters, that represent different values in various situations. (3 min)

Terms, Factors, & Coefficients

Understand how terms are the components added or subtracted, factors are the elements multiplied within each term, and coefficients are the numbers multiplying variables (7 min)

Why aren't we Using the Multiplication Sign?

Explore how representing multiplication with variables can be tricky due to the similarity between the variable "x" and the multiplication symbol. (5 min)

Evaluating an Expression with One Variable

Explore the expression 5 t plus 3 to calculate the cost of participating in a hospital raffle fundraiser. (2 min)

Evaluating Exponent Expressions with Variables

Learn to evaluate expressions with exponents and variables. (3 min)

Evaluating Expressions Like $5x^2$ & $\frac{1}{2}(6)^x$

Explore how evaluating expressions with exponents involves substituting a given value for the variable and following the order of operations. (2 min)

Evaluating Expressions with Two Variables

Learn how to evaluate expressions with two variables involves substituting the given values for each variable and simplifying the expression. (2 min)

Evaluating Expressions with Two Variables: Fractions & Decimals

Explore how to evaluate expressions with two variables involves substituting the given values for each variable and simplifying the expression. (3 min)

Expression Value Intuition

Discover how expressions change as variables within them shift. (5 min)

Evaluating Expressions with Variables: Temperature

Learn to substitute the variable with a value to solve the problem. (2 min)

Evaluating Expressions with Variables: Cubes

Discover how to calculate the total surface area of cube-shaped containers with varying side lengths. (3 min)

Evaluating Expressions with Variables: Exponents

Learn to evaluate an algebraic expression with exponents by following the order of operations (PEMDAS). (3 min)

Writing Basic Expressions with Variables

Discover how to represent various operations like addition, subtraction, multiplication, and division using variables. (3 min)

Writing Algebraic Subtraction Expressions

Learn how to turn word statements into algebraic expressions. (2 min)

Writing Expressions with Variables

Explore how to write simple algebraic expressions from mathematical statements. (2 min)

Writing Expressions with Parentheses

Explore using parentheses and how they help follow the correct order of operations. (2 min)

Writing Expressions with Variables & Parentheses

Explore expressions and how to simplify them step by step. (3 min)

Writing Basic Expressions Word Problems

Determine and write the basic expressions from this word problem. (3 min)

Least Common Multiple

Learn that the least common multiple (LCM) is the smallest number that two or more numbers can divide into evenly. (4 min)

Least Common Multiple: Repeating Factors

Determine the least common multiple of two integers. (3 min)

Least Common Multiple of Three Numbers

Explore how to find the LCM of 3 different numbers. (6 min)

Greatest Common Factor Examples

Explore and learn how the greatest common factor (GCF) of a set of numbers is the largest factor that all the numbers share. (7 min)

Greatest Common Factor Explained

Learn how to find the GCD/GCF of two numbers, list their factors, identify the common factors, and choose the largest one. (6 min)

Factor with the Distributive Property

Learn how the distributive property helps us factor out the greatest common factor (GCF) in math problems. (3 min)

Distributive Property over Addition

Learn how to apply the distributive law of multiplication over addition and why it works. (5 min)

Distributive Property over Subtraction

Learn how to apply the distributive property of multiplication over subtraction and why it works. (2 min)

Distributive Property with Variables

Learn to apply the distributive property to an algebraic expression, you multiply each term inside the parentheses by the number or variable outside the parentheses. (7 min)

Intro to Combining Like Terms

Explore how to add terms with coefficients and variables. (5 min)

Combining Like Terms

Learn how to add and subtract variables like apples(a) or x's. (3 min)

Combining Like Terms Example

Learn how to simplify algebraic expressions by combining like terms. (4 min)

Equivalent Expressions

Learn how to find equivalent expressions by combining terms and factoring. (2 min)

Algebra | Equations & Inequalities

Variables, Expressions, & Equations

Learn how to use variables like x, y, and z to represent unknown values. (7 min)

Testing Solutions to Equations

Learn how to solve an equation with one variable. (4 min)

Same Thing to Both Sides of Equations

Visualize how to keep an equation balanced with this scale problem. (3 min)

Representing a Relationship with an Equation

Learn about balancing scales and solving equations. We discover that to find a mystery mass, we can set up an equation using equal signs and balance both sides. (3 min)

Dividing Both Sides of an Equation

Learn how to find the mass of a mystery object using a balanced scale. (3 min)

One-Step Equations Intuition

Learn how to solve a balance scale problem with unknown mass. (5 min)

One-Step Addition & Subtraction Equations

Learn how to solve simple equations with one unknown variable. (2 min)

One-Step Addition Equation

Learn how to solve simple equations by isolating the variable by removing other terms on the same side. (2 min)

One-Step Addition & Subtraction Equations: Fractions & Decimals

Learn how to solve equations by learning how to isolate the variable by adding or subtracting terms from both sides of the equation. (5 min)

One-Step Division Equations

Learn how to solve simple algebraic equations systematically. (11 min)

One-Step Multiplication Equations

Learn to solve equations with x divided by a number, like $x/3 = 14$. (3 min)

One-Step Multiplication & Division Equations: Fractions & Decimals

Learn to balance equations by applying the same operation on both sides, simplifying fractions, and eliminating decimals. (8 min)

One-Step Multiplication Equations: Fractional Coefficients

Learn how to solve equations with fractions by using reciprocals. (4 min)

Finding Mistakes in One-Step Equations

Learn how to spot mistakes in solving algebraic equations. (4 min)

Modeling with One-Step Equations

Work through this problem to figure out how many pizzas can be bought with the money provided. (4 min)

Testing Solutions to Inequalities

Learn to solve inequality puzzles by trying different numbers and seeing which ones make the puzzle true. (5 min)

Plotting Inequalities

Explore how to plot inequalities on a number line. (2 min)

Plotting an Inequality Example

Visualize how x is less than 4 by using a number line. (2 min)

Inequalities Word Problems

Learn to use inequalities to compare values. (2 min)

Dependent & Independent Variables

Explore independent and dependent variables: how to identify the independent/dependent variables in each setting, and how to write equations with the dependent variable by itself. (2 min)

Dependent & Independent Variables: Graphing

Visualize how to plot the answer of a problem on a graph. (1 min)

Writing Equations for Relationships Between Quantities

Learn how to write equations representing real-world scenarios. (6 min)

Analyzing Relationships Between Variables

Explore and analyze the relationship between variables in a problem. (3 min)

Fractions, Decimals, Percents, & Ratios | Ratios

Intro to Ratios

Learn about Ratios and how they are the relationship between two numbers. (4 min)

Basic Ratios

Learn how ratios compare two quantities and can be written as "a to b" or "a:b". (3 min)

Part: Whole Ratios

Explore ratios in this visual example and learn how to represent ratios as fractions. (3 min)

Ratios with Tape Diagrams

Learn to find missing values using given ratios and discover equivalent ratios by multiplying or dividing both parts by the same number. (4 min)

Ratios with Tape Diagrams (Part:Whole)

Learn to read a part-to-whole ratio from a tape diagram showing the ratio of the two parts. (3 min)

Equivalent Ratio Word Problems

Learn to solve ratio word problems, using examples like Yoda Soda for guests, fish ratios in a tank, ice cream sundae ingredients, and dog color ratios at a park. (6 min)

Simplify a Ratio from a Tape Diagram

Use a tape diagram to simplify a ratio in this visual problem. (3 min)

Ratios and Double Number Lines

Use double number lines to visualize equivalent ratios and describe a ratio relationship between two quantities. (6 min)

Solving Ratio Problems with Tables

Learn to solve for missing values in a table. (5 min)

Equivalent Ratios

Learn to identify equivalent ratios by determining if you can multiply or divide the corresponding parts of the ratio by the same amount. (5 min)

Equivalent Ratios: Recipe

Identify the correct ratios in this cake recipe problem. (5 min)

Understanding Equivalent Ratios

Learn what it means for two ratios to be equivalent. (6 min)

Interpreting Unequal Ratios

Use this example to interpret the ratio of pepper to fish in two recipes to decide which tastes spicier. (3 min)

Ratios on Coordinate Plane

Understand and visualize that ratios represent the relationship between two quantities and can be visualized on a graph. (5 min)

Ratios and Measurement

Learn to complete ratio tables and solve unit conversion problems with examples like hours to weeks, yards to miles, millimeters to feet, and dollars per pound to dollars per ounce.

(7 min)

Part to Whole Ratio Word Problem: Using Tables

Learn to use ratios to determine the number of indoor and outdoor playtimes in a class with a 2:3 ratio and 30 total playtimes. (3 min)

Fractions, Decimals, Percents, & Ratios | Arithmetic with Rational Numbers

Adding Decimals: $9.087 + 15.31$

Learn to add decimals by filling in any missing digits to complete this problem. (3 min)

Adding Decimals: $0.822 + 5.65$

Work to solve this decimal addition problem. (2 min)

Adding Three Decimals

Work to solve this decimal addition problem. (3 min)

Subtracting Decimals: $9.005 - 3.6$

Learn to subtract decimals by lining up the decimal points. (2 min)

Subtracting Decimals: $39.1 - 0.794$

Learn to subtract decimals by aligning the decimal points and place values. (2 min)

Adding Decimals Word Problem

Solve this word problem by adding decimals to find the total weight of newborn twins. (2 min)

Adding & Subtracting Decimals Word Problem

Learn how to manage a bank account balance by adding and subtracting money with decimals. (2 min)

Dividing a Fraction by a Whole Number

Visually learn to divide fractions by whole numbers using multiplication. (4 min)

Meaning of the Reciprocal

Learn about reciprocals and how they are essential in understanding fractions. (4 min)

Dividing a Whole Number by a Fraction

Explore how dividing a whole number by a fraction involves multiplying the whole number by the fraction's reciprocal. (3 min)

Dividing a Whole Number by a Fraction with Reciprocal

Understand and visualize that dividing by a fraction involves finding the reciprocal and multiplying. (4 min)

Understanding Division of Fractions

Learn to divide mixed numbers by converting the mixed numbers to improper fractions, the simplify the division problem by finding the reciprocal of one of the fractions. (6 min)

Dividing Fractions: $2/5 \div 7/3$

Solve this word problem by dividing $2/5 \div 7/3$. (2 min)

Dividing Fractions: $3/5 \div 1/2$

Explore how dividing two fractions is the same as multiplying the first fraction by the reciprocal of the second fraction. (4 min)

Dividing Mixed Numbers

Learn to divide mixed numbers by converting them to improper fractions. (4 min)

Writing Fraction Division Story Problems

Explore how to solve this word problem involving fractions. (4 min)

Dividing Whole Numbers & Fractions: T-Shirts

Learn how to calculate the number of baby T-shirts that can be made from 48 yards of fabric. (2 min)

Area with Fraction Division Example

Discover the length of a yoga mat with a width of $3/5$ meters and an area of 1 and $2/25$ square meters. (3 min)

Intro to Multiplying Decimals

Learn how to multiply decimals. (4 min)

Decimal Multiplication Place Value

Learn about how to rewrite decimal multiplication using fractions, we can use the commutative and associative properties of multiplication to justify how we place the decimal point in the standard multiplication algorithm. (5 min)

Multiplying Challenging Decimals

Learn to multiply decimals easily by treating them as whole numbers first. (4 min)

Dividing by 2-Digits: $9,815 \div 65$

Learn the process of dividing large numbers, specifically 9,815 divided by 65. (5 min)

Dividing by 2-Digits: $7,182 \div 42$

Learn to divide large numbers by two-digit numbers by breaking it in to steps. (3 min)

Dividing Whole Numbers to Get a Decimal

Learn how to divide two numbers and find a decimal answer. (3 min)

Dividing a Decimal by a Whole Number

Learn how to divide decimals using long division. (2 min)

Dividing a Whole Number by a Decimal

Learn how dividing a whole number by a decimal can be simplified by multiplying both numbers by 10, shifting the decimal point to the right. (4 min)

Dividing Decimals with Hundredths

Explore how dividing decimals can be made simple by multiplying both numbers by the same amount to eliminate decimals. (4 min)

Dividing Decimals Completely

Learn to make dividing decimals easier by converting them into whole numbers. (7 min)

Long Division with Decimals

Learn to divide a decimal by another decimal. (4 min)

Dividing by a Multi-Digit Decimal

Work through the different steps needed to divide decimals. (5 min)

Fractions, Decimals, Percents, & Ratios | Rates & Percentages

Intro to Rates

Learn how rates are closely related to ratios and play a significant role in math subjects like algebra and calculus. (5 min)

Solving Unit Rate Problem

Visualize and explore how to solve for a unit rate. (2 min)

Solving Unit Price Problem

Visualize and explore how to solve for a unit price. (2 min)

Rate Problems

Learn to find unit rates and use them to solve problems. (4 min)

Comparing Rates Example

Visualize how to compare rates in this math problem. (7 min)

The Meaning of Percent

Visualize and learn about percentages by shading 20% of a square. (3 min)

Meaning of 109%

Visualize how to represent 109% using shading. (3 min)

Percents from Fraction Models

Learn how to rewrite the fraction with a denominator of 100, as "percent" means "per 100." (4 min)

Finding Percentages with a Double Number Line

Work to determine the percentage of students taking the bus to school in a class of 28. (2 min)

Finding the Whole with a Tape Diagram

Use a tape diagram to solve this problem. (3 min)

Fraction, Decimal, and Percent from Visual Model

Learn how to convert shaded parts of a square into fractions, decimals, and percentages with ease. (3 min)

Converting Percents to Decimals & Fractions Example

Explore how to convert percentages to decimals and fractions. (3 min)

Percent of a Whole Number

Discover how to calculate percentages with a simple example: finding 30% of 6. (2 min)

Ways to Rewrite a Percentage

Discover how to calculate 2% of 90 using various methods, such as converting percentages to fractions and decimals. (2 min)

Finding Common Percentages

Explore how to find the percentage of a number by simply multiplying or dividing by the corresponding fraction e. (3 min)

Finding a Percent

Discover how to calculate percentages with this simple method. (3 min)

Percent Word Problem: Recycling Cans

Visualize and learn how to calculate the percentage of recycled cans. (3 min)

Measurement & Data | Representing Data Sets

Representing Data

Explore a few different ways to look at data. (8 min)

Frequency Tables & Dot Plots

Learn to organize data into frequency tables and dot plots (sometimes called line plots). (7 min)

Creating a Histogram

Explore how a histogram is a graphical display of data using bars of different heights. (7 min)

Interpreting a Histogram

Learn how to read and interpret histograms, which summarize data by sorting it into buckets. (4 min)

Reading Box Plots

Box and whisker plots seek to explain data by showing a spread of all the data points in a sample. The "whiskers" are the two opposite ends of the data. (3 min)

Constructing a Box Plot

Learn how to construct a box and whisker plot to help analyze data. (8 min)

Worked Example: Creating a Box Plot (Odd Number of Data Points)

Learn how to create a box plot with 11 data points. (3 min)

Worked Example: Creating a Box Plot (Even Number of Data Points)

Learn how to create a box plot using 14 data points. (3 min)

Interpreting Box Plots

Learn how to evaluate what we know and what we don't know about a dataset given its box plot. (8 min)

Comparing Dot Plots, Histograms, and Box Plots

Learn to determine which data displays would be helpful in situations. (5 min)

Shapes of Distributions

Explore how some distributions are symmetrical, with data evenly distributed about the mean. Other distributions are "skewed," with data tending to the left or right of the mean. (5 min)

Clusters, Gaps, Peaks & Outliers

Explore examples looking at different features of distributions, such as clusters, gaps, peaks, and outliers for distributions. (6 min)

Statistics & Probability | Intro to Statistics & Data Sets

Statistical Questions

Explore what makes a question statistical. (9 min)

Representing Data

Explore a few of the many ways to look at data. (8 min)

Frequency Tables & Dot Plots

Learn to organize data into frequency tables and dot plots (sometimes called line plots). (7 min)

Creating a Histogram

Discover how a histogram is a graphical display of data using bars of different heights. (7 min)

Interpreting a Histogram

Learn how to read and interpret histograms, which summarize data by sorting it into buckets. (5 min)

Statistics Intro: Mean, Median, & Mode

Explore what the mean, median and mode is in a data set. (9 min)

Mean, Median, & Mode Example

Use a set of numbers to find the mean, median, and mode. (4 min)

Missing Value Given the Mean

Learn how to find the value of a missing piece of data if you know the mean of the data set. (5 min)

Impact on Median & Mean: Removing an Outlier

Explore the effects of removing a low outlier from a data set. (5 min)

Impact on Median & Mean: Increasing an Outlier

Explore the effects of modifying a value in a data set. (4 min)

Median & Range Puzzlers

Solve an interesting median and range challenge problem. (7 min)

Interquartile Range (IQR)

Learn to find the interquartile range (IQR) by first find the median (middle value) of the lower and upper half of the data. (6 min)

Mean Absolute Deviation (MAD)

Explore how Mean absolute deviation (MAD) of a data set is the average distance between each data value and the mean. (9 min)

Mean Absolute Deviation Example

Find the mean absolute deviation of a data set that's given in a bar chart. (6 min)

Shapes of Distributions

Explore the difference in symmetrical and "skewed" distributions. (5 min)

Clusters, Gaps, Peaks & Outliers

Explore looking at different features of distributions, such as clusters, gaps, peaks, and outliers for distributions. (7 min)

7th Grade

Basic Operations & Reasoning | Integers: Addition & Subtraction

Zero Pairs Worked Example

Explore what makes a zero pair and use integer chips to represent the numbers. (2 min)

Subtracting with Integer Chips

Use Integer chip diagrams to model and evaluate sums. (5 min)

Adding Negative Numbers on the Number Line

Learn how to model $6 + (-2)$ using vertical number lines. (5 min)

Signs of Sums on a Number Line

Let's build intuition for the sign of sum involving negative and positive numbers. (8 min)

Subtracting with Integer Chips

Model subtraction expressions using positive and negative integer chips. (5 min)

Number Equations & Number Lines

Use integer equations to describe diagram. (3 min)

Graphing Negative Number Addition and Subtraction Expressions

Explore how to graph addition and subtraction expressions involving negative numbers on the number line. (4 min)

Interpreting Numeric Expressions

Example

Choose the correct interpretation of the integer expression $3 + (-7)$. (3 min)

Adding the Opposite with Integer Chips

Use integer chips to explore the conjecture that subtracting a number gives the same result as adding the opposite of the number. (5 min)

Adding the Opposite with Number Lines

Explore the claim that subtracting a number is the same as adding its opposite using number lines. (5 min)

Subtracting a Negative = Adding a Positive

Find out why subtracting a negative number is the same as adding the absolute value of that number. (2 min)

Adding Integers: Find the Missing Value

Use number lines to find missing addends in addition equations with integers. (3 min)

Subtracting Integers: Find the Missing Value

Use number lines to find missing numbers in subtraction equations with integers. (7 min)

Substitution with Negative Numbers

Practice substituting positive and negative values for variables. (8 min)

Ordering Expressions

Let's get some practice thinking about adding and subtracting variables representing positive and negative numbers on the number line. (7 min)

Basic Operations & Reasoning | Interpreting Negative Numbers

Absolute Value as Distance Between Numbers

Explore what $|a-b|$ really means, and we verify that $|a-b| = |b-a|$ by looking at an example. (5 min)

Interpreting Absolute Value as Distance

Work through a bunch of examples that stretch our thinking on absolute value. (11 min)

Interpreting Negative Number Statements

Use examples to represent negative numbers in real world situations. (4 min)

Negative Number Word Problem: Temperature

Use a number line to solve a word problem that includes a negative number. (4 min)

Negative Number Word Problem: Alaska

Figure out the temperature in Fairbanks, Alaska by adding and subtracting negative numbers. (4 min)

Associative and Commutative Properties of Addition with Negatives

Explore how the commutative and associative properties apply to addition, but not to subtraction. (4 min)

Equivalent Expressions with Negative Numbers

Learn that we can commute and associate terms if we keep the signs with the terms. (5 min)

Basic Operations & Reasoning | Negative Numbers: Multiplication & Division

Why a Negative Times a Negative is a Positive

Use the distributive property to understand the products of negative numbers. (6 min)

Why a Negative Times a Negative Makes Sense

Use the repeated addition model of multiplication to give an understanding of multiplying negative numbers. (5 min)

Multiplying Positive & Negative Numbers

Learn some rules of thumb for multiplying positive and negative numbers. (6 min)

Dividing Positive & Negative Numbers

Learn some rules of thumb for multiplying positive and negative numbers. (5 min)

Interpreting Multiplication & Division of Negative Numbers

Let's think about the meaning of negative numbers in different situations. (4 min)

Rational Number Word Problem: Cosmetics

Convert minutes into hours and solve this word problem involving fractions. (2 min)

Exponents with Negative Bases

Learn what we know about negative numbers to determine how negative bases with exponents are affected and what patterns develop. (4 min)

1 and -1 to Different Powers

Explore different exponents affect the value of a number: when raised to the power of zero, any number equals one; when raised to an even power, negative numbers yield positive results; and when raised to an odd power, negative numbers yield negative results. (6 min)

Equivalent Expressions with Negative Numbers (Multiplication & Division)

Figure out whether some expressions are equivalent. (8 min)

Basic Operations & Reasoning | Order of Operations

Intro to Order of Operations

Show the steps and clarifies the purpose of order of operations: to have ONE way to interpret a mathematical statement. (10 min)

Worked Example: Order of Operations (PEMDAS)

Simplify and accurately solve mathematical expressions, ensuring a correct final answer. (5 min)

Order of Operations Example

Simplify this tricky expression using the order of operations. Expression includes negative numbers and exponents. (5 min)

Geometry | Scale Copies

Exploring Scale Copies

Learn to use virtual manipulatives to identify figures that scale proportionally. (2 min)

Identifying Corresponding Parts of Scaled Copies

Learn to identify corresponding parts of scaled copies. (2 min)

Corresponding Points and Sides of Scaled Shapes

Identify corresponding sides and corresponding points in scale copies of figures. (3 min)

Identifying Scale Copies

Look at side measures on figures to determine if they are scale copies. (4 min)

Identifying Scale Factor in Drawings

Identify the scale factor used to create a scale copy. (2 min)

Interpreting Scale Factors in Drawings

Interpret a scale factor to determine if a scale copy will be larger or smaller than the original figure. (2 min)

Identifying Values in Scale Copies

Identify missing side lengths in scale drawings. (4 min)

Scale Drawings

Find the missing side length in a scale drawing when given either a set of corresponding side lengths or one side length and the scale factor. (3 min)

Scale Drawing: Centimeters to Kilometers

Use ratios to figure out how far apart two cities should be on a map. (2 min)

Interpreting a Scale Drawing

Understand how a scale drawing is converted into real numbers using the scale factor. (5 min)

Creating Scale Drawings

Use real world contexts to create scale drawings on a grid. (2 min)

Making a Scale Drawing

Use your knowledge about scale factor, length, and area to assist. (3 min)

Scale Factors and Area

Explore how scale factors affect the area of a scaled figure. (6 min)

Solving a Scale Drawing Word Problem

Solve a word problem by using a scale drawing and finding the scale factor. (6 min)

Geometry | Area & Circumference of Circles

Radius, Diameter, Circumference & π

Learn how the number Pi allows us to relate the radius, diameter, and circumference of a circle. (11 min)

Labeling Parts of a Circle

Explore the different parts of a circle - radius, diameter, center, and circumference. (2 min)

Radius & Diameter from Circumference

Find the radius and diameter of a circle given the circumference. (3 min)

Relating Circumference and Area

Use formulas and a specific example to see how area and circumference relate. (5 min)

Area of a Circle

Learn how to use this formula, ($A = \pi r^2$) to find the area of a circle when given the diameter. (4 min)

Partial Circle Area and Arc Length

Find the area of a semicircle and the arc length of a partial circle. (3 min)

Finding Circumference of a Circle when Given the Area

Learn how to find the circumference, the distance around a circle, when given the area. (2 min)

Area of a Shaded Region

Find the area of a shaded region where you first determine the area of a square and then the area of a circle. (2 min)

Impact of Increasing the Radius

Learn how the circumference and area change if the radius of a circle changes. (3 min)

Geometry | Vertical, Complementary, & Supplementary Angles

Angles: Introduction

Learn about angles and the parts of an angle, like the vertex. (7 min)

Complementary & Supplementary Angles

Learn about complementary and supplementary angles, as well as the definitions of adjacent and straight angles. (8 min)

Vertical Angles

Solve problems involving the intersection of two lines. (7 min)

Vertical Angles are Congruent Proof

Explore how to prove that vertical angles are equal. (5 min)

Find Measure of Vertical Angles

Find the measure of the remaining angles given two intersecting lines and the measure of vertical angles. (3 min)

Find Measure of Angles Word Problem

Solve this word problem to find the measure of angles. (4 min)

Equation Practice with Complementary Angles

Given the algebraic expressions that represent a pair of complementary angles, learn how to form and solve an equation to find an unknown angle. (2 min)

Equation Practice with Supplementary Angles

Given the algebraic expressions that represent a pair of supplementary angles, form and solve an equation. (2 min)

Equation Practice with Vertical Angles

Given the algebraic expressions that represent a pair of supplementary angles, form and solve an equation. (2 min)

Geometry | Constructing Triangles

Construct a Right Isosceles Triangle

Learn how to build a triangle that is both a right triangle and an isosceles triangle. (2 min)

Construct a Triangle with Constraints

Learn to construct a triangle given the constraints. (4 min)

Triangle Inequality Theorem

Explore the intuition behind the triangle inequality theorem. (6 min)

Geometry | Volumes

Slicing a Rectangular Pyramid

Learn what happens when you slice vertically into a rectangular pyramid. (3 min)

Volume Word Problem: Gold Ring

Find the incremental volume of a ring in cubic inches. (3 min)

Volume of Triangular Prism & Cube

Using the formulas for the volume of triangular prism and cube to solve some solid geometry problems. (4 min)

Volume of Rectangles Inside Rectangles

Learn to solve for the volume of rectangles inside rectangles. (5 min)

Cylinder Volume & Surface Area

Learn how to find the volume of a cylinder using these formulas; $c \pi r^2 h$, and its surface area is $2\pi r h + 2\pi r^2$. (8 min)

Volume of a Sphere

Use the formula for the volume of a sphere is $V = \frac{4}{3} \pi r^3$, where V = volume and r = radius. (3 min)

Volume of a Cone

Explore the formula for the volume of a cone is $V = \frac{1}{3} \pi r^2 h$. (6 min)

Algebra | Proportional Relationships

Introduction to Proportional Relationships

Explore proportional relationships are relationships between two variables where their ratios are equivalent. (5 min)

Identifying Constant of Proportionality Graphically

Identify the constant of proportionality from a line graphed on a coordinate plane. (4 min)

Constant of Proportionality from Graph

Learn how to find a constant of proportionality by looking at the graph of a line. (2 min)

Identifying the Constant of Proportionality from Equation

Understanding what a constant of proportionality is and how to identify it in an equation. (4 min)

Constant of Proportionality from Equation

Identify the constant of proportionality from equations. (2 min)

Constant of Proportionality from Tables

Identifying proportionality constants by looking at tables of values. (3 min)

Constant of Proportionality from Table (With Equations)

Identify the constant of proportionality from table. (2 min)

Comparing Constants of Proportionality

Explore an example comparing constants of proportionality. (4 min)

Comparing Proportionality Constants

Compare constants of proportionality in various forms, such as graphs, equations, contexts, diagrams, and tables. (3 min)

Interpret Proportionality Constants

Interpret what the constant of proportionality means in a context. (3 min)

Intro to Proportional Relationships

Explore if a relationship is proportional, you should look at the ratios between the two variables. (4 min)

Proportional Relationships: Movie Tickets

Use this example to determine if the price you pay is proportional to the number of tickets that are bought. (2 min)

Proportional Relationships: Bananas

Explore a proportionality problem about eating bananas. (3 min)

Proportional Relationships: Spaghetti

Explore a table of ratios and test them for equivalence and determine whether the relationship is proportional. (1 min)

Proportional Relationships

Determine which ratios are proportionate to a ratio provided in a context. (4 min)

Is Side Length & Area Proportional?

Solve the question by drawing a square and thinking about the relationship between side length and area. (4 min)

Is Side Length & Perimeter Proportional?

Solve by drawing a square and thinking about the relationship between side length and perimeter. (3 min)

Identifying Proportional Relationships from Graphs

Identify proportional relationships from graphs. (3 min)

Proportional Relationships: Graphs

Learn how to tell proportional relationships by drawing graphs. (7 min)

Interpreting Graphs of Proportional Relationships

Interpret graphs of proportional relationships. (3 min)

Worked Example: Solving Proportions

Learn the reasoning behind solving proportions. (7 min)

Writing Proportions Example

Explore examples of writing two ratios and setting them equal to solve proportion word problems. (6 min)

Proportion Word Problem: Cookies

Explore how to solve this word problem about proportion involving cookies. (6 min)

Proportion Word Problem: Hot Dogs

Solve this proportion word problem involving hot dogs. (5 min)

Equations for Proportional Relationships

Learn how to write a proportional equation $y=kx$ where k is the so-called "constant of proportionality". (5 min)

Writing Proportional Equations from Tables

Write an equation to describe the relationship between the number of scoops in an ice cream cone and the price. (3 min)

Writing Proportional Equations

Figure out the constant of proportionality when dealing with a constant rate. (2 min)

Algebra | Expressions

Intro to Combining Like Terms

Explore adding like terms is a fundamental concept in algebra. (4 min)

Combining Like Terms with Negative Coefficients & Distribution

Explore how to layer the distributive property on top of using order of operations and combining like terms. (4 min)

Combining Like Terms with Negative Coefficients

Solve this example of combining like terms in an expression. (5 min)

Combining Like Terms with Rational Coefficients

Learn how to rewrite algebraic expressions by combining like terms that have decimals and fraction coefficients. (4 min)

The Distributive Property with Variables

Learn how to apply the distributive property to factor out the greatest common factor from an algebraic expression like $2+4x$. (6 min)

Factoring with the Distributive Property

Learn how to factor the expression $4x+18$ into the expression $2(2x+9)$. (4 min)

Equivalent Expressions: Negative Numbers & Distribution

Learn how to identify equivalent expressions using your knowledge of the distributive property and negative numbers. (4 min)

Interpreting Linear Expressions: Diamonds

Match the expression to their meanings regarding linear expressions. (2 min)

Interpreting Linear Expressions: Flowers

Let's practice matching expressions to their meaning in this example of interpreting linear expressions. (2 min)

Writing Expressions Word Problems

Learn how to write expressions with variables to describe situations described in word problems. (5 min)

Algebra | Equations

Same Thing to Both Sides of Equations

Solve for the mystery mass's weight by using a balance scale. (2 min)

Intro to Two-Step Equations

Solve a two-step equation using the concept of equality: what we do to one side of the equation must be done to the other. (5 min)

Two-Step Equations Intuition

Demonstrate how we solve an equation expressed such: $ax + b = c$. (9 min)

Worked Example: Two-Step Equations

Solve the equation $-16 = x/4 + 2$. (3 min)

Two-Step Equations with Decimals and Fractions

Learn how to solve equations that involve decimals and fractions. (8 min)

Two-Step Equations with Decimals and Fractions

Let's practice some two step equations, some of which require merging terms and using the distributive property. (14 min)

Find the Mistake: Two-Step Equations

Explore how to check our own work (and other people's work) for correctness. (4 min)

6.EE.6, 6.EE.9, Equation Word Problem: Super Yoga (Part 1)

Using information from the super yoga word problem, explore all the possible combinations and create equations which express the possibilities. (7 min)

Equation Word Problem: Super Yoga (Part 2)

Using information from the super yoga word problem, explore all the possible combinations and create equations which express the possibilities. (8 min)

Two-Step Equation Word Problem: Computers

Learn how to construct and solve a basic linear equation to solve a word problem. (5 min)

Two-Step Equation Word Problem: Garden

Solve this word problem and find the dimensions of a garden given only the perimeter. (2 min)

Two-Step Equation Word Problem: Oranges

Learn how to solve a word problem by writing an equation to model the situation. (6 min)

Algebra | Inequalities

Testing Solutions to Inequalities

Explore how inequalities are like puzzles where you compare two things. (5 min)

One-Step Inequalities Examples

Explore how linear inequalities begin with multiplying and dividing by negative numbers. (10 min)

One-Step Inequalities: $-5c \leq 15$

Solve the inequality, we'll graph the solution. (3 min)

One-Step Inequality Word Problem

Explore how inequalities are used in real life problems. (2 min)

Two-Step Inequalities

Learn how to solve a two-step inequalities problem. (4 min)

Two-Step Inequality Word Problem: Apples

Solve this word problem about apples involving two-step inequality. (6 min)

Two-Step Inequality Word Problem: R&B

Interpret the information and then construct a linear inequality to solve it. (2 min)

Fractions, Decimals, Percents, & Ratios | Rates & Percentages

Rates with Fractions

Solve an example problem with rates with fractions. (5 min)

Rewriting Decimals as Fractions: 2.75

Solve an example of how we convert a decimal to a simplified fraction. (3 min)

Worked Example: Converting a Fraction (7/8) to a Decimal

Learn how to write the fraction, $7/8$ as a decimal. (2 min)

Fraction to Decimal: 11/25

Write $11/25$ as a decimal (2min)

Fraction to Decimal with Rounding

Learn to write $16/21$ as a rounded decimal. (3 min)

Comparing Rational Numbers

Explore how to compare Rational Numbers. (7 min)

Solving Percent Problems

Solve this percent problem using algebra. (6 min)

Percent Word Problem: Magic Club

Solve percent word problems including percent comparisons and percent of change. (8 min)

Percent Word Problems: Tax and Discount

Solve percent word problems involving tax, tip, and discounts. (6 min)

Percent Word Problem: Guavas

Solve this percent word problem to find the full price when you know the discount price. (6 min)

Fractions, Decimals, Percents, & Ratios | Rational Numbers: Addition & Subtraction

Adding Fractions with Different Signs

Use a number line to add fractions with different signs. (4 min)

Adding and Subtracting Fractions with Negatives

Use the properties of addition to strategically add and subtract fractions with negatives and unlike denominators. (4 min)

Adding & Subtracting Rational Numbers: 79% - 79.1 - 58 1/10

Evaluate how to add/subtract rational numbers. (5 min)

Adding & Subtracting Rational Numbers: 0.79 - 4/3 - 1/2 + 150%

Evaluate how to add/subtract rational numbers. (4 min)

Fractions, Decimals, Percents, & Ratios | Rational Numbers: Multiplication & Division

Rational Number Word Problem: School Report

Visualize this word problem then use subtraction and multiplication of decimals and fractions to get at the answer. (4 min)

Rational Number Word Problem: Ice

Determine the volume of frozen water and express the answer as a fraction. (3 min)

Rational Number Word Problem: Computers

Compare the weight of two objects using a ratio of integers. (3 min)

Rational Number Word Problem: Stock

Utilize proportions and fractions to determine shareholders profit in this word problem. (4 min)

Rational Number Word Problem: Checking Account

Use your knowledge of decimals and adding negative and positive numbers to bring your account back into the black. (3 min)

Negative Signs in Fractions

Solve and find equivalent expressions to $-g/h$. (5 min)

Expressions with Rational Numbers

Learn to compare expressions with positive and negative fractions. (6 min)

Multiplying Positive and Negative Fractions

Explore examples of multiplying and dividing fractions with negative numbers. (4 min)

Dividing Negative Fractions

Explore how dividing by a fraction is the same as multiplying by its reciprocal. (4 min)

Dividing Mixed Numbers

Explore how to change mixed numbers into improper fractions, divide, and then change the answer back to a mixed number. (3 min)

Statistics & Probability | Intro to Statistics & Probability

Intro to Theoretical Probability

Explore probability through the example of flipping a quarter and rolling a die. (8 min)

Simple Probability: Yellow Marble

In order to find the probability of picking a yellow marble from a bag, we must first determine the number of possible outcomes, and then how many of them meet our constraints. (3 min)

Simple Probability: Non-Blue Marble

Explore this example we are figuring out the probability of randomly picking a non-blue marble from a bag. (10 min)

Experimental Probability

Explore how to make reasonable estimates of the likelihood of future events. (7 min)

Intuitive Sense of Probabilities

Explore what probabilities really mean. (9 min)

Theoretical and Experimental Probabilities

Compare expected probabilities to what really happens when we run experiments. (7 min)

Making Predictions with Probability

Explore how theoretical probability helps to predict the number of times a spinner will land on an elephant. (5 min)

Probability Models Example: Frozen Yogurt

Model the probability of a frozen yogurt line having 0, 1, or 2 people in it. (8 min)

Sample Spaces for Compound Events

Explore the notion of a "sample space". See a sample space represented as a tree diagram, table, and list. (9 min)

Die Rolling Probability

Explore the probability of rolling doubles on a pair of dice and create a grid of all possible outcomes. (5 min)

Probability of a Compound Event

Learn how to use sample space diagrams to find probabilities. (5 min)

Counting Outcomes: Flower Pots

Find the number of ways you can put four types of flowers into three types of pots. (2 min)

Count Outcomes Using Tree Diagram

Explore how tree diagrams can be used to find the number of possible outcomes and calculate the probability of possible outcomes. (4 min)

Reasonable Samples

Explore how to make a valid conclusion, you'll need a representative, not skewed, sample. (4 min)

Comparing Distributions with Dot Plots (Example Problem)

Examine two distributions in dot plots to draw conclusions about the times of Olympic swimmers. (4 min)

8th Grade

Basic Operations & Reasoning | Repeating Decimals

Converting a Fraction to a Repeating Decimal

Learn to convert a fraction like $\frac{19}{27}$ into a decimal, you should divide 27 into 19 and use the remainder to figure out the decimal. (4 min)

Converting Repeating Decimals to Fractions (Part 1)

Learn the process of converting a repeating decimal to a fraction can be broken down into a few easy steps. (4 min)

Converting Repeating Decimals to Fractions (Part 2)

Learn how repeated decimals can be converted into fractions by shifting the decimal to the right and subtracting the decimals. (9 min)

Basic Operations & Reasoning | Square & Cube Roots

Intro to Square Roots

Learn about the square root symbol (the principal root) and what it means to find a square root. (5 min)

Intro to Cube Roots Learn the meaning of cube roots and how to find them. Also learn how to find the cube root of a negative number. (8 min)

Worked Example: Cube Root of a Negative Number

Learn how to find the cube root of negative 512 by breaking it down into prime factors. (4 min)

Square Root of a Decimal

Learn how to find the square root of a decimal number. (3 min)

Dimensions of a Cube from its Volume

When we know the volume of a cube, we can use the cube root of the volume to find the length of each side. (3 min)

Basic Operations & Reasoning | Intro to Irrational Numbers

Intro to Rational & Irrational Numbers

Learn the difference between rational and irrational numbers, learn how to identify them, and discover why some of the most famous numbers in mathematics, like Pi and e, are irrational. (6 min)

Classifying Numbers: Rational & Irrational

Learn to write any rational number as the ratio of two integers. (2 min)

Classifying Numbers

Learn to classify numbers as one of these four categories: rational numbers, irrational numbers, integers, and whole numbers. (9 min)

Worked Example: Classifying Numbers

Decide which number set 3.4028 belongs to: integer, rational, or irrational. (7 min)

Approximating Square Roots

Learn how to find the approximate values of square roots. (5 min)

Comparing Irrational Numbers with Radicals

Learn how to sort a bunch of numbers ($4\sqrt{2}$ $2\sqrt{3}$ $3\sqrt{2}$ $\sqrt{17}$ $3\sqrt{3}$ 5) from least to greatest without using a calculator. (6 min)

Approximating Square Roots to Hundredths

Explore how to find the perfect squares around 45 and use them to make an educated guess. (7 min)

Comparing Values with Calculator

Learn how to compare 22.9% to $\sqrt{0.45}$ using a calculator. (4 min)

Basic Operations & Reasoning | Properties of Exponents

Exponents with Negative Bases

Learn to what we know about negative numbers to determine how negative bases with exponents are affected and what patterns develop. (5 min)

The 0 & 1st Power

Learn different ways of thinking about exponents. (5 min)

Even & Odd Numbers of Negatives

Explore whether multiplication and division problems give us a positive or negative result by thinking about how many negative numbers are used in the computation. (7 min)

1 and -1 to Different Powers

Explore the different exponents affect the value of a number: when raised to the power of zero, any number equals one; when raised to an even power, negative numbers yield positive results; and when raised to an odd power, negative numbers yield negative results. (6 min)

Powers of Zero

Explore what happens when you have zero to the zero powers. (4 min)

Sign of Expressions Challenge Problems

Explore your understanding of what happens when we multiply or divide a bunch of positive or negative numbers. (9 min)

Exponent Properties with Products

Learn the different properties that help to simplify expressions with exponents. (14 min)

Exponent Properties with Parentheses

Learn two exponent properties: $(ab)^c = (a^c)(b^c)$ and $(a^b)^c = a^{(b*c)}$. (6 min)

Exponent Properties with Quotients

Learn how to simplify expressions like $(5^6)/(5^2)$. Also learn how $1/(a^b)$ is the same as a^{-b} . (9 min)

Negative Exponents

Explore how negative exponents can be rewritten. (7 min)

Negative Exponent Intuition

Learn how negative exponents work. (5 min)

Multiplying & Dividing Powers (Integer Exponents)

Learn that any base a and any integer exponents n and m , $a^n \cdot a^m = a^{n+m}$. For any non-zero base, $a^n/a^m = a^{n-m}$. (4 min)

Powers of Products & Quotients (Integer Exponents)

For any integers a and b and for any exponents n , $(a \cdot b)^n = a^n \cdot b^n$ and $(a/b)^n = a^n/b^n$. These are worked examples for using these properties with integer exponents. (7 min)

Multiplying Multiples of Powers of 10

Learn how to multiply $(9 \cdot 10^9)(-2 \cdot 10^{-3})$. (3 min)

Approximating with Powers of 10

Learn how to approximate how much larger the world population was than the US population in 2014. (4 min)

Basic Operations & Reasoning | Scientific Notation

Scientific Notation Example:

0.000000003457

Explore scientific notation and see examples of it. (4 min)

Scientific Notation Examples

Learn about Scientific notation and explore examples. (11 min)

Multiplying & Dividing in Scientific Notation

In order to simplify multiplication and division using scientific notation, you should multiply and divide numbers with the same base and add or subtract the exponents. (3 min)

Multiplying Three Numbers in Scientific Notation

Explore why multiplying very big or very small numbers is much easier when using scientific notation. (8 min)

Subtracting in Scientific Notation

Learn how to subtract numbers written in scientific notation. (4 min)

Simplifying in Scientific Notation Challenge

Solve a hairy expression and simplify in scientific notation. (6 min)

Scientific Notation Word Problem: Red Blood Cells

Use scientific notation to solve how many red blood cells are in the human body. (5 min)

Scientific Notation Word Problem: U.S. National Debt

Use scientific notation to solve what your part of the national debt is. (6 min)

Scientific Notation Word Problem: Speed of Light

Learn to simplify multiplication and division using scientific notation. (5 min)

Geometry | Angles Between Intersecting Lines

Angles, Parallel Lines, & Transversals

When a third line, called a transversal, crosses these parallel lines, it creates angles. Some angles are equal, like vertical angles (opposite angles) and corresponding angles (same position at each intersection). (7 min)

Parallel & Perpendicular Lines

Parallel lines are lines that never intersect, and they form the same angle when they cross another line. Perpendicular lines intersect at a 90-degree angle, forming a square corner. (4 min)

Missing Angles with a Transversal

When a third line called a transversal crosses two parallel lines, we can find the measures of angles using properties like corresponding angles, vertical angles, and supplementary angles. (2 min)

Measures of Angles Formed by a Transversal

Solve an equation to find missing angles given two parallel lines and a transversal. (5 min)

Angles in a Triangle Sum to 180° Proof

Explore how the sum of the interior angle measures of a triangle always adds up to 180° . (4 min)

Isosceles & Equilateral Triangles Problems

Explore the differences between isosceles & equilateral triangles. (6 min)

Triangle Exterior Angle Example

Explore how to find angle measures by using exterior angles. (6 min)

Worked Example: Triangle Angles (Intersecting Lines)

Learn how to find unknown angles in triangles and intersecting lines. (5 min)

Worked Example: Triangle Angles (Diagram)

Find the missing angle measures in the triangles by using this fact and looking at complementary (adding up to 90 degrees) and supplementary (adding up to 180 degrees) angles. (6 min)

Triangle Angle Challenge Problem

Learn about the sum of exterior angles in a polygon, specifically a pentagon. (8 min)

Triangle Angle Challenge Problem 2

Find angle measures in triangles when the given measures are algebraic expressions. (6 min)

Geometry | Triangle Angles

Angles in a Triangle Sum to 180° Proof

Explore how the sum of the interior angle measures of a triangle always adds up to 180° . (4 min)

Isosceles & Equilateral Triangles Problems

Use the properties of Isosceles triangles to find the missing angles in composite figures. (6 min)

Triangle Exterior Angle Example

Discover how exterior angles are formed outside a triangle by extending a side. (6 min)

Worked Example: Triangle Angles (Intersecting Lines)

Learn how to find unknown angles in triangles and intersecting lines. (5 min)

Worked Example: Triangle Angles (Diagram)

Find the missing angle measures in the triangles by using the knowledge you have of triangle angles. (6 min)

Triangle Angle Challenge Problem 1

Learn about the sum of exterior angles in a polygon, specifically a pentagon. (8 min)

Triangle Angle Challenge Problem 2

Find angle measures in triangles when the given measures are algebraic expressions. (6 min)

Geometry | Pythagorean Theorem

Intro to the Pythagorean Theorem

The Pythagorean theorem is a cornerstone of math that helps us find the missing side length of a right triangle. In a right triangle with sides A, B, and hypotenuse C, the theorem states that $A^2 + B^2 = C^2$. The hypotenuse is the longest side, opposite the right angle. (11 min)

Pythagorean Theorem Example

Apply the Pythagorean theorem to find the missing side length of a right triangle, even when the missing length is one of the shorter sides. (4 min)

Pythagorean Theorem with Isosceles Triangle

Learn to find the value of a base (x) in an isosceles triangle. (4 min)

Use Pythagorean Theorem to Find Area of an Isosceles Triangle

Learn to find the area of an isosceles triangle using the Pythagorean theorem. (4 min)

Pythagorean Theorem Word Problem: Carpet

Use the Pythagorean theorem to solve the missing width of the carpet. (3 min)

Pythagorean Theorem Word Problem: Fishing Boat

Solve this word problem using Pythagorean theorem. (4 min)

Pythagorean Theorem in 3D

Discover how to find the length of an edge in a 3D shape using the Pythagorean theorem. (6 min)

Distance Formula

Learn how to find the distance between two points by using the distance formula, which is an application of the Pythagorean theorem. (10 min)

Garfield's Proof of the Pythagorean Theorem

Use a trapezoid made of two identical right triangles and half of a square to show that the sum of the squares of the two shorter sides equals the square of the longest side of a right triangle. (9 min)

Bhaskara's Proof of the Pythagorean Theorem

Explore mathematician Bhaskara's elegant visual proof of the Pythagorean theorem. (9 min)

Pythagorean Theorem Proof Using Similarity

Explore proof of the Pythagorean theorem using similarity. (10 min)

Another Pythagorean Theorem Proof

Visualize how to prove the Pythagorean theorem. (11 min)

Geometry | Intro to Transformations

Rigid Transformations Intro

Explore the three main types: translations (moving the shape), rotations (turning the shape), and reflections (flipping the shape like a mirror image). (7 min)

Dilations Intro

Explore how dilations are a type of non-rigid transformation. (2 min)

Identifying Transformations

Explore the four types of transformations: rotations (spinning a shape around a point), translations (shifting a shape), reflections (flipping a shape over a line), and dilations (shrinking or expanding a shape). (4 min)

Geometry | Types & Properties of Transformations

Translating Points

Explore how a translation is a way to move a point or shape by a certain number of units in a certain direction on a coordinate plane. (4 min)

Translating Shapes

Explore how to translate shapes. (2 min)

Determining Translations

Learn how to find the translation by figuring out how much the x- and y-coordinates need to change to map one triangle onto the other. (2 min)

Rotating Points

Explore what it means to rotate angles and how positive and negative rotations affect the angles. (2 min)

Determining Rotations

Discover how to see the angle of rotation. (3 min)

Reflecting Points

Explore Reflections and how to create mirror images of points, keeping the same distance from the line. (4 min)

Reflecting Shapes

Find new points (A', B', C', D') by keeping the same x-coordinates and changing the y-coordinates to their opposite signs. (3 min)

Determining Reflections

Explore a line of reflection is an imaginary line that flips one shape onto another. (2 min)

Finding Measures Using Rigid Transformations

Explore how to find the measurements after a rigid transformation. (5 min)

Rigid Transformations: Preserved Properties

Explore how rigid transformations, like rotations and reflections, change a shape's position but keep its size and shape. (7 min)

Mapping Shapes

Find the right sequence of rigid transformations (like rotations, translations, and reflections) to map one triangle onto another. (9 min)

Geometry | Dilations

Dilating Points

Discover how dilations are a way to stretch or shrink shapes around a point called the center of dilation. (3 min)

Dilations: Scale Factor

Explore how to scale dilations. (5 min)

Dilating Shapes: Expanding

Let's dilate a rectangle around a point P using a scale factor $1\frac{2}{3}$. (3 min)

Dilating Shapes: Shrinking by $\frac{1}{2}$

Find the new positions of the points after dilation. (3 min)

Dilations and Properties

Explore whether the properties of a shape are preserved or not preserved after a dilation. (6 min)

Geometry | Congruence & Similarity

Congruent Shapes & Transformations

Explore how congruent shapes and transformations can be congruent. (2 min)

Non-Congruent Shapes & Transformations

Explore how dilations affect congruency. (2 min)

Similar Shapes & Transformations

Explore how two shapes are similar if we can change one shape into the other using rigid transformations (like moving or rotating) and dilations (making it bigger or smaller). (3 min)

Side Lengths After Dilation

Explore how in a dilation, if the scale factor is greater than 1, the shape will stretch away from the center of dilation, getting larger. If the scale factor is between 0 and 1, the shape will shrink towards the center, getting smaller. All the lengths in the figure change by the same scale factor. (2 min)

Algebra | Solving Equations with One Unknown

Intro to Equations with Variables on Both Sides

Learn to solve the equation $2x + 3 = 5x - 2$. (9 min)

Equations with Variables on Both Sides: $20 - 7x = 6x - 6$

Solve the equation $20 - 7x = 6x - 6$. (4 min)

Equation with Variables on Both Sides: Fractions

Solve the equation $(3/4)x + 2 = (3/8)x - 4$. (5 min)

Equation with the Variable in the Denominator

Solve the equation $7 - 10/x = 2 + 15/x$. (4 min)

Equations with Parentheses

Solve the equation $-9 - (9x - 6) = 3(4x + 6)$ using the distributive property. (6 min)

Number of Solutions to Equations

See how some equations have one solution, others have no solutions, and still others have infinite solutions. (5 min)

Worked Example: Number of Solutions to Equations

Explore the equation $8(3x + 10) = 28x - 14 - 4x$ and try to find the solutions. (2 min)

Creating an Equation with No Solutions

Show how to complete the equation $-11x + 4 = __x + __$ so that it has no solutions. (2 min)

Creating an Equation with Infinitely Many Solutions

Show how to complete the equation $4(x - 2) + x = 5x + __$ so that it has infinitely many solutions. (2 min)

Sums of Consecutive Integers

Use algebra to set up an equation to solve for the smallest of the four integers. (5 min)

Sum of Integers Challenge

Solve the following problem: the sum of three consecutive odd integers is 231. (4 min)

Algebra | Graphing Proportional Relationships

Rates & Proportional Relationships Example

Explore and compare a rate given in an equation to a rate shown on a graph. (2 min)

Rates & Proportional Relationships: Gas Mileage

Choose equations that give a faster rate than the relationship given in a table. (3 min)

Graphing Proportional Relationships: Unit Rate

Graph the equation of a line that represents a proportional relationship given a unit rate. (4 min)

Graphing Proportional Relationships from a Table

Graph the equation of a line that represents a proportional relationship given a table. (2 min)

Graphing Proportional Relationships from an Equation

Graph the equation of a line that represents a proportional relationship given an equation. (3 min)

Algebra | Solutions to Linear Equations

Intro to the Coordinate Plane

Explore how to create a system of two perpendicular axes (the x and y axes) which could be used to plot points in a plane. (11 min)

Solutions to 2-Variable Equations

Learn about what an ordered pair and how to test solutions to 2-variable equations. (3 min)

Worked Example: Solutions to 2-Variable Equations

Learn how to check if an ordered pair is a solution to a given equation. (3 min)

Completing Solutions to 2-Variable Equations

Given a 2-variable equation and the x or y values of a solution find the value of the other variable in the solution. (7 min)

Algebra | Intercepts

| Intro to Intercepts

Learn what x- and y-intercepts are. (6 min)

X-Intercept of a Line

Determine the x-intercept of a linear equation from a graph. (2 min)

Intercepts from an Equation

Find the x and y-intercepts of $-5x + 4y = 20$. (4 min)

Intercepts from a Table

Find the y-intercept of the graph of a linear function given a table of values. (4 min)

Worked Example: Intercepts from an Equation

Find the x and y-intercepts of the equation $2y + \frac{1}{3}x = 12$. (4 min)

Algebra | Slope

Intro to Slope-Intercept Form

Learn how to calculate the slope of the line in a graph by finding the change in y and the change in x. (7 min)

Slope & Direction of a Line

Find the slope of a line given its graph. (3 min)

Positive & Negative Slope

Find the slope of the line that goes through the ordered pairs (4,2) and (-3, 16). (5 min)

Slope from Graph

Worked examples of finding the slope of a line given its equation, using many forms of equations. (5 min)

Slope of a Line: Negative Slope

Learn to convert equations like $4x + 2y = -8$ into slope-intercept form. (4 min)

Slope from Equation

When two points have the same y-value, it means they lie on a horizontal line. The slope of such a line is 0, and you will also find this by using the slope formula. (6 min)

Worked Example: Slope from Two Points

Find the slope of the line that goes through the ordered pairs (4,2) and (-3, 16). (7 min)

Converting to Slope-Intercept Form

Learn to convert equations like $4x + 2y = -8$ into slope-intercept form. (5 min)

Slope of a Horizontal Line

When two points have the same y-value, it means they lie on a horizontal line. The slope of such a line is 0, and you will also find this by using the slope formula. (5 min)

Algebra | Slope-Intercept Form

Intro to Slope-Intercept Form

Slope-intercept form ($y=mx+b$) of linear equations highlights the slope (m) and the y-intercept (b) of a line. (9 min)

Worked Examples: Slope-Intercept Intro

Explore the relationship between slope, y-intercept, and linear equation in slope-intercept form. (4 min)

Graph from Slope-Intercept Equation

Graph a linear equation in slope-intercept form, (3 min)

Slope-Intercept Equation from Graph

Learn to write equations in slope-intercept form for three different lines. (11 min)

Slope-Intercept Equation from Slope & Point

Learn how to write an equation in slope-intercept form ($y=mx+b$) for the line with a slope of $-\frac{3}{4}$ that goes through the point (0,8). (4 min)

Slope-Intercept Equation from Two Points

Write an equation of the line that passes through the points (-1,6) and (5,-4). (7 min)

Slope-Intercept Form Problems

Learn how to solve problems involving writing an equation in slope-intercept form. (15 min)

Slope-Intercept Form from a Table

Learn how to write an equation of the line that matches up to a table of values. (4 min)

Algebra | Linear Equations & Functions

What is a Function?

Visualize examples of various kinds of functions. (8 min)

Worked Example: Evaluating Functions from Equation

Learn how to evaluate $f(x)=49-x^2$ at $x=5$. (1 min)

Function Notation Example

Use function notation to help Frank figure out how much water he can put in his balloon. (2 min)

Worked Example: Evaluating Functions from Graph

Evaluating a function at $x=-1$ using the graph of that function. (1 min)

Equations vs. Functions

Explore the difference between equations and functions. (4 min)

Manipulating Formulas: Temperature

Use the formula for converting from Fahrenheit to Celsius and solve it for F to convert from Celsius to Fahrenheit. (3 min)

Obtaining a Function from an Equation

Learn to obtain a function from an equation. The function represents the same relationship between the quantities in the equation. (3 min)

Linear Graphs Word Problems

Explore how we would go about making sense of the direction of a linear graph that represents a relationship between two real-world quantities. (5 min)

Linear Graphs Word Problem: Cats

Find the y-intercept and the slope of a linear relationship representing someone accumulating cats. (3 min)

Linear Equations Word Problems: Volcano

Find the y-intercept and the slope of a linear relationship representing someone climbing a volcano. (6 min)

Linear Equations Word Problems: Earnings

Find the slope of a linear relationship between the number of work hours and the money earned. (4 min)

Modeling with Linear Equations: Snow

Use a linear equation to model the amount of snow on the ground. (5 min)

Linear Function Example: Spending Money

Solve an interesting application problem using a linear model. (5 min)

Fitting a Line to Data

Learn to create a scatter plot and then fit a line to data on the median California family income. (8 min)

Comparing Linear Functions: Equation vs. Graph

Solve for a given the formula of a linear function and the graph of another and determine which function increases faster. (2 min)

Comparing Linear Functions: Same Rate of Change

Solve when given a table of values of a linear function and four linear graphs and determine which graph has the same rate of change as the function represented in the table. (2 min)

Comparing Linear Functions: Faster Rate of Change

Solve when given a table of values of a linear function and four linear graphs and determine which graph increases faster than the function represented in the table. (4 min)

Comparing Linear Functions Word Problem: Climb

Solve when given the formula and a table of values that represent two people climbing a wall and determine which one started out higher. (5 min)

Comparing Linear Functions Word Problem: Walk

Solve when given a table of values that represents four people walking to school and determine which one started out farther from the school. (4 min)

Comparing Linear Functions Word Problem: Work

Solve when given a table of values that represents a person walking to work and determine which verbal description represents someone starting at the same distance from work. (4 min)

Linear Functions Word Problem: Fuel

Examine this real-world relationship and draw the graph that represents this relationship best. (5 min)

Linear Functions Word Problem: Pool

Examine this real-world relationship and draw the graph that represents this relationship best. (3 min)

Modeling with Linear Equations: Gym Membership & Lemonade

Constructing linear equations to solve word problems. (10 min)

Linear Functions Word Problem: Iceberg

Examine this real-world relationship and find the formula of the function that represents this relationship. (6 min)

Linear Functions Word Problem: Paint

Examine this real-world relationship and find the formula of the function that represents this relationship. (8 min)

Testing if a Relationship is a Function

Learn to determine if points on a graph represent a function. (2 min)

Relations and Functions

Learn to determine if a relation given by a set of ordered pairs is a function. (7 min)

Recognizing Functions from Graph

Checking whether a given set of points can represent a function. (4 min)

Checking if a Table Represents a Function

Determine if y is a function of x from looking at a table. (1 min)

Recognizing Functions from Table

Checking whether a table of people and their heights can represent a function that assigns a height to a name. (5 min)

Checking if an Equation Represents a Function

Determine if y is a function of x from looking at an equation. (4 min)

a Vertical Line Represent a Function?

Explaining why a vertical line doesn't represent a function. (2 min)

Recognizing Functions from Verbal Description

Check whether y can be described as a function of x if y is always three more than twice x. (2 min)

Recognizing Functions from Verbal Description Word Problem

Check whether a description of the price of an order can be represented as a function of the shipping cost. (3 min)

Recognizing Linear Functions

Learn to recognize if a function is linear. (4 min)

Linear & Nonlinear Functions: Table

Learn to determine if a table of values represents a linear function. (2 min)

Linear & Nonlinear Functions: Word Problem

Learn to determine if the relationship described in a word problem is a function. (4 min)

Linear & Nonlinear Functions: Missing Value

Learn to find the missing value in a table to make sure it represents a linear equation. (2 min)

Interpreting a Graph Example

Learn to interpret the graphs of linear functions. (2 min)

Algebra | Intro to Systems of Equations

Systems of Equations: Trolls, Tolls (Part 1)

Explore this troll of a problem and learn about setting up a system of equations. (7 min)

Systems of Equations: Trolls, Tolls (Part 2)

Explore this troll of a problem and learn about setting up a system of equations. (6 min)

Testing a Solution to a System of Equations

Check whether $(-1, 7)$ is a solution of the system: $x + 2y = 13$ and $3x - y = -11$. (2 min)

Algebra | Solving Systems of Equations with Graphing

Systems of Equations with Graphing

When solving systems of linear equations, one method is to graph both equations on the same coordinate plane. The intersection of the two lines represents a solution that satisfies both equations. (8 min)

Systems of Equations with Graphing: $y = 7/5x - 5$ & $y = 3/5x - 1$

Graph the following system of equations and solve it by looking for the intersection point: $y = 7/5x - 5$ and $y = 3/5x - 1$. (2 min)

Systems of Equations with Graphing: $5x + 3y = 7$ & $3x - 2y = 8$

Learn how to solve a system of linear equations by graphing each equation separately. (6 min)

Systems of Equations with Graphing: Chores

Solve this Graphical Systems Application Problem. (5 min)

Systems of Equations with Graphing: Exact & Approximate Solutions

Solve a system of two linear equations in standard form and then approximate the solution of a system whose solution isn't clearly visible. (6 min)

Algebra | Solving Systems of Equations with Substitution

Systems of Equations with Substitution: $2y = x + 7$ & $x = y - 4$

When solving a system of equations using substitution, you can isolate one variable and substitute it with an expression from another equation. (4 min)

Systems of Equations with Substitution: $y = 4x - 17.5$ & $y + 2x = 6.5$

Learn to solve the system of equations $y = 4x - 17.5$ and $y + 2x = 6.5$ using substitution. (4 min)

Systems of Equations with Substitution: $-3x - 4y = -2$ & $y = 2x - 5$

Learn to solve the system of equations $-3x - 4y = -2$ and $y = 2x - 5$ using substitution. (4 min)

Systems of Equations with Substitution: $9x + 3y = 15$ & $y - x = 5$

Learn to solve the system of equations $9x + 3y = 15$ and $y - x = 5$ using substitution. (6 min)

Systems of Equations with Substitution: $y = -5x + 8$ & $10x + 2y = -2$

Learn to solve the system of equations $y = -5x + 8$ and $10x + 2y = -2$ using substitution. (4 min)

Systems of Equations with Substitution: $y = -1/4x + 100$ & $y = -1/4x + 120$

Learn to solve the system of equations $y = -1/4x + 100$ and $y = -1/4x + 120$ using substitution. (4 min)

Algebra | Number of Solutions to Systems of Equations

Systems of Equations Number of Solutions: Fruit Prices (Part 1)

Explore an example of a system of equations that has no solutions. (9 min)

Systems of Equations Number of Solutions: Fruit Prices (Part 2)

Explore an example of a system of equations that has infinite solutions. (7 min)

Solutions to Systems of Equations: Dependent vs. Independent

Explore an example of analyzing a system to see if it's dependent or independent system of equations. (5 min)

Number of Solutions to a System of Equations

When given three lines on the coordinate plane, identify one system of two lines that has a single solution, and one system that has no solution. (3 min)

Number of Solutions to a System of Equations Graphically

Determine how many solutions the following system of equations has by considering its graph: $10x - 2y = 4$ and $10x - 2y = 16$. (6 min)

Number of Solutions to a System of Equations Algebraically

Solve several examples about the number of solutions of systems of equations using algebraic reasoning. (6 min)

How Many Solutions Does a System of Linear Equations Have if There are At Least Two?

Explore the solution to this question. (2 min)

Algebra | Systems of Equations Word Problems

Age Word Problem: Imran

Solve the following age word problem: In 40 years, Imran will be 11 times as old as he is right now. How old is he right now? (4 min)

Age Word Problem: Ben & William

Solve the following age word problem: William is 4 times as old as Ben. 12 years ago, William was 7 times as old as Ben. How old is Ben now? (6 min)

Age Word Problem: Arman & Diya

Solve the following age word problem: Arman is 18. Diya is 2. How many years will it take for Arman to be 3 times as old as Diya? (5 min)

System of Equations Word Problem: Walk & Ride

Solve a problem about distances, walking and riding bus to school. (7 min)

System of Equations Word Problem: No Solution

Solve a problem about a toy factory. (5 min)

System of Equations Word Problem: Infinite Solutions

Solve a problem about a vegetable farmer. (5 min)

Systems of Equations with Substitution: Coins

Solve a word problem about the number of nickels and quarters in a piggy bank by creating a system of equations and solving it. (6 min)

Measurement & Data | Data & Modeling

Constructing a Scatter Plot

Explore how to construct a scatter plot from information provided. (2 min)

Example of Direction in Scatter Plots

Discover how to compare different graphs in this example. (2 min)

Scatter Plot: Smokers

Explore how a negative linear association goes up, as one variable goes up, the other variable goes down at a constant rate. (2 min)

Estimating the Line of Best Fit Exercise

Explore how to find the line of best fit when looking for a linear trend. (1 min)

Line of Best Fit: Smoking in 1945

Discover how to guess how many smoked in 1945 by drawing a line that slopes down through the points. (5 min)

Estimating with Linear Regression (Linear Models)

Explore how line of best fit is a straight line that shows the relationship between two sets of data. (3 min)

Interpreting a Trend Line

Use the graph to show how studying affects test scores. (3 min)

Two-Way Frequency Tables and Venn Diagrams

Discover how to use Venn Diagrams and two-way tables. (6 min)

Two-Way Relative Frequency Tables

Calculate the relative frequency of accidents for SUVs by dividing the number of SUVs that had accidents by the total number of SUVs. (4 min)

Interpreting Two-Way Tables

Explore how two-way tables help us understand how categories relate. (2 min)

Algebra I

Geometry | Equations & Geometry

Equation Practice with Segment Addition

Solve for the value of x by splitting a line segment into two segments. (4 min)

Equation Practice with Midpoints

Given information about the distance of a segment's midpoint from its endpoints, Sal forms and solves an equation to find the length of the segment. (3 min)

Equation Practice with Vertical Angles

Given algebraic expressions that represent a pair of vertical angles, form and solve an equation. (2 min)

Equation Practice with Complementary Angles

Given the algebraic expressions that represent a pair of complementary angles, learn how to form and solve an equation to find an unknown angle. (2 min)

Equation Practice with Supplementary Angles

Given the algebraic expressions that represent a pair of supplementary angles, form and solve an equation. (2 min)

Geometry | Pythagorean Theorem

Intro to the Pythagorean Theorem 1

Discover that the Pythagorean theorem is a cornerstone of math that helps us find the missing side length of a right triangle. (11 min)

Intro to the Pythagorean Theorem 2

Explore the Pythagorean Theorem in more depth. (13 min)

Pythagorean Theorem Example

Learn to apply the theorem to find the missing side length of a right triangle, even when the missing length is one of the shorter sides. (4 min)

Pythagorean Theorem with Isosceles Triangle

Find the value of a base (x) in an isosceles triangle by splitting the triangle into two congruent right triangles by drawing an altitude. (3 min)

Use Pythagorean Theorem to Find Area of an Isosceles Triangle

Find the area of an isosceles triangle using the Pythagorean theorem. (4 min)

Pythagorean Theorem Word Problem: Carpet

Given the length and diagonal measurements, use the Pythagorean theorem to solve for the missing width of the carpet. (3 min)

Pythagorean Theorem Word Problem: Fishing Boat

Model the length of a rope stretched between the mast and deck as the hypotenuse of a right triangle. (4 min)

Pythagorean Theorem in 3D

Discover how to find the length of an edge in a 3D shape using the Pythagorean theorem. (6 min)

Distance Formula

Learn how to find the distance between two points by using the distance formula, which is an application of the Pythagorean theorem. (9 min)

Garfield's Proof of the Pythagorean Theorem

Explore former U.S. President James Garfield's proof of the Pythagorean theorem. (9 min)

Bhaskara's Proof of the Pythagorean Theorem

Explore how Bhaskara uses a square and four congruent right triangles, rearranged in two ways, to prove this theorem. (9 min)

Pythagorean Theorem Proof Using Similarity

Proof of the Pythagorean theorem using similarity. (10 min)

Another Pythagorean Theorem Proof

Visually proving the Pythagorean theorem. (10 min)

Geometry | Similar Triangles

Intro to Triangle Similarity

Explore what it means for triangles to be similar, and how this follows from the definition of similarity. (9 min)

Triangle Similarity Postulates & Criteria

Review all the different ways we can determine that two triangles are similar. (12 min)

Determining Similar Triangles

Analyze multiple examples of the similarity of triangles. (9 min)

Solving Similar Triangles

Solve two problems where a missing side length is found by proving that triangles are similar and using this to find the measure. (7 min)

Solving Similar Triangles: Same Side Plays Different Roles

Find a missing side length in a problem where the same side plays different roles in two similar triangles. (7 min)

Angles in a Triangle Sum to 180° Proof

Use transversals, vertical angles, and corresponding angles to rearrange those angle measures into a straight line, proving that they must add up to 180°. (5 min)

Algebra | Overview & History of Algebra

Origins of Algebra

Explore how algebra began and where its underlying ideas come from. (7 min)

Abstract-Ness

Explore what abstraction is. (7 min)

The Beauty of Algebra

Learn why the abstraction of mathematics is so fundamental. (10 min)

Creativity Break: Why is Creativity Important in Algebra?

Students and professionals share what makes creativity so important in algebra. (2 min)

Intro to the Coordinate Plane

Learn about how Descartes created a system of two perpendicular axes (the x and y axes) which could be used to plot points in a plane. (11 min)

Why All the Letters in Algebra?

In algebra, we often want to work with general concepts instead of specific numbers. Using letters allows us to represent quantities that could change or that we don't know the value of yet. Letters can also be used to generalize formulas or equations. (3 min)

Algebra | Intro to Variables

What is a Variable?

Variables in math are symbols, often letters, that represent different values in various situations. They help us understand and solve problems with changing values. (3 min)

Why Aren't We Using the Multiplication Sign?

In algebra, representing multiplication with variables can be tricky due to the similarity between the variable "x" and the multiplication symbol. (5 min)

Creativity Break: Why is Creativity Important in STEM Jobs?

Experts share why creativity plays an important role in STEM jobs. (2 min)

Evaluating an Expression with One Variable

Explore the expression $5t+3$ to calculate the cost of participating in a hospital raffle fundraiser. (2 min)

Algebra | Combining Like Terms

Intro to Combining Like Terms

Coefficients are the numbers in front of variables, and they can be added when the variables are the same. For example, $2x + 3x$ equals $5x$. When dealing with different variables, such as x and y , add them separately, resulting in expressions like $5x + 9y$. (4 min)

Combining Like Terms with Negative Coefficients & Distribution

You've learned about order of operations and combining like terms. Let's layer the distributive property on top of this. (4 min)

Combining Like Terms with Negative Coefficients

This example of combining like terms in an expression gets a little hairy. Pay attention. (5 min)

Combining Like Terms with Rational Coefficients

Learn how to rewrite algebraic expressions by combining like terms. (5 min)

Equivalent Expressions

Learn how to find equivalent expressions by combining like terms and factoring. (2 min)

Algebra | Division by Zero

Why Dividing by Zero is Undefined

Learn why dividing by zero is undefined. (4 min)

The Problem with Dividing Zero by Zero

Explore why $0/0$ is undetermined. (3 min)

Undefined & Indeterminate Expressions

Using general mathematical considerations, we see why those are undefined and indeterminate problems. (8 min)

Algebra | Linear Equations with Variables on Both Sides

Why We Do the Same Thing to Both Sides: Variable on Both Sides

Use a scale to try to achieve balance and help explain why we do the same thing to both sides of an equation, even when the variable appears on both sides. (3 min)

Intro to Equations with Variables on Both Sides

Learn to solve the equation $2x + 3 = 5x - 2$. (9 min)

Equations with Variables on Both Sides: 20-7x=6x-6

Solve the equation $20 - 7x = 6x - 6$. (4 min)

Equation with Variables on Both Sides: Fractions

Solve the equation $(3/4)x + 2 = (3/8)x - 4$. (5 min)

Equation with the Variable in the Denominator

Solve the equation $7 - 10/x = 2 + 15/x$. (4 min)

Algebra | Analyzing Linear Equations

Equations with Parentheses

Solve the equation $-9 - (9x - 6) = 3(4x + 6)$ using the distributive property. (6 min)

Reasoning with Linear Equations

When we perform operations to manipulate equations, some operations produce equivalent equations, while others don't necessarily produce equivalent equations. (8 min)

Number of Solutions to Equations

Explore how some equations have one solution, others have no solutions, and still others have infinite solutions. (6 min)

Worked Example: Number of Solutions to Equations

Attempt to solve $8(3x + 10) = 28x - 14 - 4x$ only to find that the equation has no solution. (2 min)

Creating an Equation with No Solutions

Explore how to complete the equation $-11x + 4 = __x + __$ so that it has no solutions. (2 min)

Creating an Equation with Infinitely Many Solutions

Explore how to complete the equation $4(x - 2) + x = 5x + __$ so that it has infinitely many solutions. (2 min)

Linear Equations with Unknown Coefficients

Solve the equations $ax + 3x = bx + 5$ and $a(5 - x) = bx - 8$ for x . (6 min)

Algebra | Compound Inequalities

Compound Inequalities: OR

Solve the compound inequality $5z + 7 < 27$ OR $-3z \leq 18$. (4 min)

Compound Inequalities: AND

Solve the compound inequality $3y + 7 < 2y$ AND $4y + 8 > -48$. (5 min)

A Compound Inequality with No Solution

Explore the compound inequality $5x - 3 < 12$ AND $4x + 1 > 25$ and find why there's no x -value that makes both inequalities true. (3 min)

Double Inequalities

Solve the double inequality $-16 \leq 3x + 5 \leq 20$, which is the same as the compound inequality $-16 \leq 3x + 5$ AND $3x + 5 \leq 20$. (4 min)

Compound Inequalities Examples

Solve several compound linear inequalities. (12 min)

Algebra | Working with Units

Intro to Dimensional Analysis

Explore how we can treat units of measurement algebraically and use these tools to convert between different units of the same quantity. (7 min)

Same Rate with Different Units

Explore how we can describe the rate 50 km per hour in a variety of different units, using dimensional analysis. (10 min)

N-Q.2 | Defining Appropriate Quantities for Modeling

Explore examples for different ways to define how quantities of interest are calculated in a modeling problem. (6 min)

Formulas and Units: Volume of a Pool

Explore how to use formulas to calculate real-world quantities and make them consistent. (3 min)

Formulas and Units: Comparing Rates

Explore how to use formulas to calculate real-world quantities and make them consistent. (4 min)

Reporting Measurements

Discover the appropriate level of precision of different measurements in modeling problems. (6 min)

Using Units to Solve Problems:

Toy Factory

Find the value of toys produced at a factory using information that involves many different quantities, not all of which are useful for our problem. (3 min)

Using Units to Solve Problems: Road Trip

Find the cost of fuel for a road trip, using information that involves many different quantities, not all of which are useful for our problem. (4 min)

Using Units to Solve Problems: Drug Dosage

Explore this unit conversion word problem that deals with converting drug dosage units, something that is commonly done in hospitals. (11 min)

Algebra | Intro to 2-Variable Linear Equations

Two-Variable Linear Equations Intro

Learn about a class of equations in two variables that's called "linear equations." They are called that way because their graph is a line. (8 min)

Evaluating Expressions with Two Variables

Explore how to evaluate expressions with multiple variables involves substituting given values for each variable and simplifying the expression. (3 min)

Evaluating Expressions with Two Variables: Fractions & Decimals

Explore evaluating expressions with two variables involves substituting the given values for each variable and simplifying the expression. (3 min)

Solutions to 2-Variable Equations

Learn more about ordered pairs and how to test solutions to 2-variable equations. (3 min)

Worked Example: Solutions to 2-Variable Equations

Explore how to check if an ordered pair is a solution to a given equation. (3 min)

Completing Solutions to 2-Variable Equations

Given a 2-variable equation and the x or y values of a solution, find the value of the other variable in the solution. (7 min)

Algebra | Slope

Intro to Slope

Explore how to find the slope of a line. (7 min)

Positive & Negative Slope

Analyze what it means for a slope to be positive or negative. (5 min)

Worked Example: Slope from Graph

Learn how to calculate the slope of the line in a graph by finding the change in y and the change in x. (5 min)

Graphing a Line Given Point and Slope

Practice graphing a line given its slope and a point the line passes through. (3 min)

Calculating Slope from Tables

Practice calculating the slope of a line given some points on the line shown in a table. (3 min)

Slope of a Horizontal Line

When two points have the same y-value, it means they lie on a horizontal line. The slope of such a line is 0, and you will also find this by using the slope formula. (5 min)

Horizontal & Vertical Lines

Identify the equations and slope of horizontal and vertical lines. (5 min)

Algebra | X-Intercepts & Y-Intercepts

Intro to Intercepts

Learn what x- and y-intercepts are. (7 min)

X-Intercept of a Line

Determine the x-intercept of a linear equation from a graph. (2 min)

Intercepts from an Equation

Find the x and y-intercepts of $-5x + 4y = 20$. (4 min)

Intercepts from a Table

Find the y-intercept of the graph of a linear function given a table of values. (4 min)

Algebra | Applying Intercepts & Slopes

Slope, X-Intercept, Y-Intercept Meaning in Context

Practice determining what each of the slope, x-intercept, and y-intercept represent in each linear relationship. (4 min)

Slope and Intercept Meaning in Context

Practice determining which feature of a linear model (the slope, the x-intercept, or the y-intercept) is useful for answering a given question in context. (2 min)

Slope and Intercept Meaning from a Table

Given a linear relationship in a table, graph the relationship to explore what the slope and intercepts mean in the given context. (7 min)

Finding Slope and Intercepts from Tables

Given a linear relationship in a table, practice finding the slope and intercepts. (6 min)

Linear Functions Word Problem: Fuel

Draw the graph that represents this relationship when given a verbal description of a real-world relationship involving a truck's fuel consumption. (6 min)

Comparing Linear Rates Example

Compare the positions of two creatures moving at constant speed and determine when one catches up with the other. (8 min)

Algebra | Forms of Linear Equations

Intro to Slope-Intercept Form

Learn about the slope-intercept form ($y=mx+b$) of linear equations highlighting the slope (m) and the y-intercept (b) of a line. (9 min)

Slope and

Y-Intercept from Equation

In an equation in slope-intercept form ($y=mx+b$) the slope is m and the y-intercept is b . We can also rewrite certain equations to look more like slope-intercept form. For example, $y=x$ can be rewritten as $y=1x+0$, so its slope is 1 and its y-intercept is 0. (4 min)

Worked Examples: Slope-Intercept Intro

Explore and practice the relationship between slope, y-intercept, and linear equation in slope-intercept form. (4 min)

Linear Equation Word Problems

Solve this linear equation word problem. (4 min)

Graph from Slope-Intercept Equation

Graph a linear equation in slope-intercept form using the information given by that form. (3 min)

Slope-Intercept Equation from Graph

Learn to write equations in slope-intercept form for three different lines. (11 min)

Slope-Intercept Equation from Slope & Point

Learn how to write an equation in slope-intercept form ($y=mx+b$) for the line with a slope of $-3/4$ that goes through the point $(0,8)$. (4 min)

Slope-Intercept Equation from Two Points

Explore how to write an equation of the line that passes through the points $(-1,6)$ and $(5,-4)$. (7 min)

Constructing Linear Equations from Context

Given a written description of a linear relationship in some context, write an equation that represents the linear relationship described. (3 min)

Intro to Point-Slope Form

Learn about how point-slope is the general form $y-y_1=m(x-x_1)$ for linear equations. It emphasizes the slope of the line and a point on the line (that is not the y-intercept). (6 min)

Point-Slope & Slope-Intercept Equations

Learn to rewrite an equation in point-slope form to be in slope-intercept form $y=mx+b$, to highlight the same line's slope and y-intercept. (7 min)

Intro to Linear Equation Standard Form

Explore the standard form for linear equations in two variables is $Ax+By=C$. (8 min)

Graphing a Linear Equation: $5x+2y=20$

Graph graph a linear equation like $5x + 2y = 20$ by rewriting it so y is isolated, then plugging in x values to find their corresponding y -values in a table. (5 min)

Clarifying Standard Form Rules

Learn and clarify what standard form rules. (5 min)

Converting from Slope-Intercept to Standard Form

Rewrite the slope-intercept equation $y=2/3x+4/7$ in standard form. (5 min)

Slope from Equation

Find the slope of a line given its equation, using many forms of equations. (6 min)

| Writing Linear Equations in all Forms

Find the equation of a line that passes through $(-3,6)$ and $(6,0)$ in point-slope, slope-intercept, and standard form. (8 min)

Algebra | Intro to Systems of Equations

Systems of Equations: Trolls, Tolls (Part 1)

Solve this troll of a problem by setting up a system of equations. (7 min)

Systems of Equations: Trolls, Tolls (Part 2)

Solve this troll of a problem by setting up a system of equations. (6 min)

Testing a Solution to a System of Equations

Check whether $(-1,7)$ is a solution of the system: $x+2y=13$ and $3x-y=-11$. (3 min)

Systems of Equations with Graphing: $y=7/5x-5$ & $y=3/5x-1$

Graph the following system of equations and solve it by looking for the intersection point: $y=7/5x-5$ and $y=3/5x-1$. (2 min)

Systems of Equations with Graphing: Exact & Approximate Solutions

Solve a system of two linear equations in standard form and then approximate the solution of a system whose solution isn't clearly visible. (6 min)

Setting up a System of Equations from Context Example (Pet Weights)

Practice writing a system of linear equations that fits the constraints in a word problem. (2 min)

Setting up a System of Linear Equations Example (Weight and Price)

Practice writing a system of linear equations that fits the constraints in a word problem.

(4 min)

Interpreting Points in Context of Graphs of Systems

Given a graph of a system of equations and a context, practice interpreting what various points represent in that system. (6 min)

Algebra | Solving Systems of Equations with Substitution

Systems of Equations with Substitution: Potato Chips

Learn to solve a system of equations using substitutions. (5 min)

Systems of Equations with Substitution: $-3x-4y=-2$ & $y=2x-5$

Learn to solve the system of equations $-3x - 4y = -2$ and $y = 2x - 5$ using substitution.

(4 min)

Systems of Equations with Substitution: Coins

Solve a word problem about the number of nickels and quarters in a piggy bank by creating a system of equations and solving it. (6 min)

Algebra | Solving Systems of Equations with Elimination

Systems of Equations with Elimination: King's Cupcakes

Use simple elimination to figure out how many cupcakes children and adults eat. (9 min)

Elimination Strategies

Practice identifying strategies for eliminating variables in a system of equations. (7 min)

Systems of Equations with Elimination: $x-4y=-18$ & $-x+3y=11$

Solve the following system of equations by eliminating x : $x-4y=-18$ and $-x+3y=11$.

(6 min)

Systems of Equations with Elimination: Potato Chips

Solve another system of equations using elimination. (9 min)

Systems of Equations with Elimination and Manipulation

Explore how to slightly manipulate a system of equations before we can solve it using the elimination method. (12 min)

Algebra | Equivalent Systems of Equations

Why can We Subtract One Equation from the Other in a System of Equations?

Revisit the example of the scale to help explain why we can subtract one equation from the other in a system of equations. (8 min)

Worked Example: Equivalent Systems of Equations

Analyze a couple systems of equations and determine whether they have the same solution as a third given system. (6 min)

Worked Example: Non-Equivalent Systems of Equations

Analyze a couple of systems of equations and determine whether they have the same solution as a third given system. (5 min)

Reasoning with Systems of Equations

When we perform operations on a system of equations, some operations produce an equivalent system, while others don't necessarily produce an equivalent system.

When we're solving a system of equations, we need to use operations that guarantee equivalence. (9 min)

Algebra | Number of Solutions to Systems of Equations

Systems of Equations Number of Solutions: Fruit Prices (Part 1)

Explore an example of a system of equations that has no solution. (9 min)

Systems of Equations Number of Solutions: Fruit Prices (Part 2)

Explore an example of a system of equations that has infinite solutions. (7 min)

Solutions to Systems of Equations: Consistent vs. Inconsistent

Learn about a consistent system of equations that has at least one solution, and an inconsistent system that has no solution. (6 min)

Solutions to Systems of Equations: Dependent vs. Independent

Explore how a dependent system of equations has infinite solutions, and an independent system has a single solution. (5 min)

Number of Solutions to a System of Equations

Given three lines on the coordinate plane, identify one system of two lines that has a single solution and one system that has no solution. (3 min)

Number of Solutions to a System of Equations Graphically

Determine how many solutions the following system of equations has by considering its graph: $10x-2y=4$ and $10x-2y=16$. (7 min)

Number of Solutions to a System of Equations Algebraically

Solve several examples where he reasons about the number of solutions of systems of equations using algebraic reasoning. (6 min)

How Many Solutions Does a System of Linear Equations Have if There are At Least Two?

Discover the answer to how many solutions a system of linear equations has. (2 min)

Algebra | Systems of Equations Word Problems

Age Word Problem: Imran

Solve the following age word problem: In 40 years, Imran will be 11 times as old as he is right now. How old is he right now? (4 min)

Age Word Problem: Ben & William

Solve the following age word problem: William is 4 times as old as Ben. 12 years ago, William was 7 times as old as Ben. How old is Ben now? (6 min)

Age Word Problem: Arman & Diya

Solve the following age word problem: Arman is 18. Diya is 2. How many years will it take for Arman to be 3 times as old as Diya? (5 min)

System of Equations Word Problem: Walk & Ride

Solve a problem about walking and bus distances to school. (7 min)

System of Equations Word Problem: No Solution

Solve a problem about a toy factory that has no viable solution, which means the information describes an impossible situation. (5 min)

System of Equations Word Problem: Infinite Solutions

Solve a problem about a vegetable farmer that has infinite solutions, which means there's not enough information to find a single solution. (5 min)

Systems of Equations with Elimination: TV & DVD

Solve a word problem about the weights of TVs and DVDs by creating a system of equations and solving it. (6 min)

Systems of Equations with Elimination: Apples and Oranges

Solve a word problem about the price of apples and oranges by creating a system of equations and solving it. (5 min)

Systems of Equations with Substitution: Coins

Solve a word problem about the number of nickels and quarters in a piggy bank by creating a system of equations and solving it. (6 min)

Systems of Equations with Elimination: Coffee and Croissants

Solve a word problem about the price of coffee and a croissant by creating a system of equations and solving it. (4 min)

Algebra | Testing & Graphing Two-Variable Inequalities

Testing Solutions to Inequalities

Check if the ordered pairs (3,5) and (1,-7) are solutions of the inequality $5x-3y \geq 25$. (6 min)

Testing Solutions to Systems of Inequalities

Check whether the ordered pair (2,5) is a solution of the following system: $y \geq 2x+1$ and $x > 1$. (1 min)

Intro to Graphing Two-Variable Inequalities

Learn how to graph two-variable linear inequalities like $y \leq 4x+3$. (8 min)

Graphing Two-Variable Inequalities

Graph the inequality $y < 3x+5$. (3 min)

Two-Variable Inequalities from Their Graphs

Analyze the given graph to find the two-variable inequality it represents. (3 min)

Intro to Graphing Systems of Inequalities

Learn how to graph systems of two-variable linear inequalities, like " $y > x-8$ and $y < 5-x$ ". (6 min)

Graphing Systems of Inequalities

Graph the solution set of the system " $y \geq 2x+1$ and $y < 2x-5$ and $x > 1$ ". (3 min)

Algebra | Modeling with Linear Inequalities

Writing Two-Variable Inequalities Word Problem

Solve a word problem about scores in a chess tournament by creating a two-variable linear inequality. (2 min)

Solving Two-Variable Inequalities Word Problem

Given a two-variable linear inequality that models a context about watering plants, find how many flowers can be watered. (4 min)

Interpreting Two-Variable Inequalities Word Problem

Analyze a two-variable linear inequality that models a context about YouTube videos.

(4 min)

Modeling with Systems of Inequalities

Model a real-world context into an algebraic system of linear inequalities and graph it.

(10 min)

Writing Systems of Inequalities Word Problem

Model a word problem about baking cupcakes and muffins by creating a system of linear inequalities. (4 min)

Solving Systems of Inequalities Word Problem

Given a system of linear inequalities that models a context about making chairs and tables, find how many can be made. (4 min)

Graphs of Systems of Inequalities Word Problem

Given the graph of a two-variable linear inequality that models a context about chopping vegetables, find if there is time to chop them. (4 min)

Graphs of Two-Variable Inequalities Word Problem

Given the graph of a two-variable linear inequality that models a context about dog biscuits, find if the dog can get enough biscuits. (5 min)

Algebra | Evaluating Functions

What is a Function?

Explore examples of various kinds of functions. (8 min)

Worked Example: Evaluating Functions from Equation

Learn how to evaluate $f(x)=49-x^2$ at $x=5$. (1 min)

Worked Example: Evaluating Functions from Graph

Evaluate a function at $x=-1$ using the graph of that function. (1 min)

Evaluating Discrete Functions

Given the graph of a discrete function, show how to evaluate the function for a few different values. (3 min)

Worked Example: Evaluating Expressions with Function Notation

Evaluate $-2 \cdot f(-6) + g(1)$ given the graphs of f and g . (1 min)

Worked Example: Matching an Input to a Function's Output (Equation)

Find the input value for which $f(t)=13$, given that $f(t)=-2t+5$. (1 min)

Worked Example: Matching an Input to a Function's Output (Graph)

Find the input value for which $g(x)=-2$ given the graph of g . (1 min)

Worked Example: Two Inputs with the Same Output (Graph)

Find the input value other than -5 for which $f(x)=f(-5)$, given the graph of f . (2 min)

Equations vs. Functions

Explore the difference between equations and functions. (4 min)

Obtaining a Function from an Equation

Learn how to obtain a function from an equation. (3 min)

Function Notation Word Problem: Bank

Learn how to interpret expressions that contain a function within a real-world context. (3 min)

Function Notation Word Problem: Beach

Learn how to interpret expressions that contain a function within a real-world context. (2 min)

Algebra | Intro to the Domain & Range of a Function

Intervals and Interval Notation

Learn about intervals, which are bounded sets of numbers and are very useful when describing domain and range. (9 min)

What is the Domain of a Function?

Explore how functions assign outputs to inputs. (7 min)

What is the Range of a Function?

Learn the range of a function is the set of all possible outputs the function can produce. (7 min)

Worked Example: Domain and Range from Graph

Finding the domain and the range of a function that is given graphically. (4 min)

Determining Whether Values are in Domain of Function

Discover how to test whether a value is or isn't in the domain of a function. (5 min)

Examples Finding the Domain of Functions

Discover how to algebraically find the domain of a few different functions. (4 min)

Worked Example: Determining Domain Word Problem (Real Numbers)

Determine the domain of a function that models the height of a plant over time. (3 min)

Worked Example: Determining Domain Word Problem (Positive Integers)

Determine the domain of a function that models the price of candy bars. (3 min)

Worked Example: Determining Domain Word Problem (All Integers)

Determine the domain of a function that models going up and down a ladder. (5 min)

Algebra | Recognizing Functions

Recognizing Functions from Graph

Explore whether a given set of points can represent a function. (4 min)

Does a Vertical Line Represent a Function?

Explain why a vertical line doesn't represent a function (2 min)

Recognizing Functions from Table

Check whether a table of people and their heights can represent a function that assigns a height to a name. (5 min)

Recognizing Functions from Verbal Description

Check whether y can be described as a function of x if y is always three more than twice x . (2 min)

Recognizing Functions from Verbal Description Word Problem

Check whether a description of the price of an order can be represented as a function of the shipping cost. (3 min)

Algebra | Interpreting Properties & Features of Functions

Introduction to Minimum and Maximum Points

Explain all about minimum and maximum points, both absolute and relative. (6 min)

Worked Example: Absolute and Relative Extrema

How to identify relative and absolute extrema in the graph of a function. (5 min)

Increasing, Decreasing, Positive or Negative Intervals

Function values can be positive or negative, and they can increase or decrease as the input increases. Here we introduce these basic properties of functions. (6 min)

Worked Example: Positive & Negative Intervals

Finding the positive or negative intervals of a function from its graph. (1 min)

Graph Interpretation Word Problem: Temperature

When a function models a real-world context, we can learn a lot about the content from the function's graph. (4 min)

Graph Interpretation Word Problem: Basketball

Interpret the y -intercept of a graph that models a basketball free throw. (4 min)

Algebra | Average Rate of Change

Intro to Average Rate of Change

Explore the average rate of change of a function over an interval. (6 min)

Worked Example: Average Rate of Change from Graph

Finding the interval in a function's graph where the function has an average rate of change of -4 . (2 min)

Worked Example: Average Rate of Change from Table

Finding the average rate of change of a function over the interval $-5 < x < -2$, given a table of values of the function. (2 min)

Average Rate of Change Word Problem: Table

Compare the average rate of change of temperature over different time periods. (4 min)

Average Rate of Change Word Problem: Graph

Find the average rate of descent of a skydiver over a specific time interval. (7 min)

Algebra | Intro to Inverse Functions

Intro to Inverse Functions

Explore how to algebraically find the inverse of a function and look at the graphical relationship between inverse functions. (9 min)

Inputs & Outputs of Inverse Functions

Explore if $f(a)=b$, then $f^{-1}(b)=a$, or in other words, the inverse function of output a when its input is b . (6 min)

Graphing the Inverse of a Linear Function

Given a line segment on the coordinate plane, graph the inverse of the function represented by that segment. (2 min)

Finding Inverse Functions: Linear

Find the inverses of $f(x)=-x+4$ and $g(x)=-2x-1$. (7 min)

Algebra | Arithmetic Sequences

Sequences Intro

Explore and discover how Sequences are ordered lists of numbers (called "terms"), like 2, 5, 8. (8 min)

Intro to Arithmetic Sequences

Discover arithmetic sequences and their main features, the initial term and the common difference. (7 min)

Extending Arithmetic Sequences

Discover how to extend the arithmetic sequences -8, -14, -20, -26, ... and 2, -1, -4, -7, -10, ... to find their next terms. (1 min)

Using Arithmetic Sequences Formulas

Find the terms of arithmetic sequences using their explicit and recursive formulas. (4 min)

Worked Example: Using Recursive Formula for Arithmetic Sequence

Practice finding the 4th term in a recursively defined arithmetic sequence. (3 min)

Recursive Formulas for Arithmetic Sequences

Find the recursive formula of the arithmetic sequence 4, $3\frac{3}{5}$, $3\frac{2}{5}$, $3\frac{1}{5}$, ... (3 min)

Explicit Formulas for Arithmetic Sequences

Find explicit formulas of arithmetic sequences given the first few terms of those sequences. (6 min)

Arithmetic Sequence Problem

Find the 100th term in the sequence 15, 9, 3, -3, ... (6 min)

Converting Recursive & Explicit Forms of Arithmetic Sequences

Find the solution when given an arithmetic sequence in explicit form and convert it to recursive form. (6 min)

Algebra | Geometric Sequences

Intro to Geometric Sequences

Discover geometric sequences and their main features, the initial term and the common ratio. (11 min)

Extending Geometric Sequences

Find the next term in the geometric sequence $-\frac{1}{32}$, $\frac{1}{8}$, $-\frac{1}{2}$, 2, ... (2 min)

Using Explicit Formulas of Geometric Sequences

Find the 5th term in the geometric sequence whose explicit formula is $3(-\frac{1}{4})^{(i-1)}$. (2 min)

Using Recursive Formulas of Geometric Sequences

Find the 4th term in the sequence whose recursive formula is $a(1)=-\frac{1}{8}$, $a(i)=2a(i-1)$. (4 min)

Explicit & Recursive Formulas for Geometric Sequences

Find an explicit formula of a geometric sequence given the first few terms of the sequences. (6 min)

Converting Recursive & Explicit Forms of Geometric Sequences

Solve the following problem: The explicit formula of a geometric sequence is $g(x)=9 \cdot 8^{(x-1)}$. (6 min)

Algebra | More with Sequences

Sequences Word Problems

Solve two-word problems about modeling real-world situations with arithmetic and geometric sequences. (6 min)

Evaluating Sequences in Recursive Form

Show how to evaluate a sequence that is defined with a recursive formula. (9 min)

Sequences and Domain

Learn how to generate the same sequence with different functions and different domains. (6 min)

Algebra | Absolute Value Functions

Shifting Absolute Value Graphs

Explore how the graph of $y=|x-h|+k$ is the graph of $y=|x|$ shifted h units to the right and k units up. (6 min)

Scaling & Reflecting Absolute Value Functions: Equation

Find the equation of an absolute value function from a description of the transformation performed on $y=|x|$. (4 min)

Scaling & Reflecting Absolute Value Functions: Graph

Find the equation of an absolute value function from its graph. (3 min)

Graphing Absolute Value Functions

Explore how to graph any absolute value equation of the form $y=k|x-a|+h$ by thinking about function transformations (horizontal shifts, vertical shifts, reflections, and scalings). (6 min)

Algebra | Piecewise Functions

| Introduction to Piecewise Functions

Learn about how a piecewise function is a function built from pieces of different functions over different intervals. (4 min)

Worked Example: Evaluating Piecewise Functions

Learn to evaluate piecewise functions (find the value of the function) by using their formulas or their graphs. (4 min)

Worked Example: Graphing Piecewise Functions

Learn to graph a piecewise function by graphing each individual piece. (4 min)

Worked Example: Domain & Range of Step Function

Learn to find the domain and range of a piecewise function that is constant in each segment. Such functions are called "step functions". (3 min)

Worked Example: Domain & Range of Piecewise Linear Functions

Finding the domain and range of a piecewise function where each segment is linear. (7 min)

Algebra | Exponents & Radicals

Multiplying & Dividing Powers (Integer Exponents)

Explore how any base and any integer exponents n and m , $a^n \cdot a^m = a^{n+m}$. For any nonzero base, $a^n / a^m = a^{n-m}$. (5 min)

Powers of Products & Quotients (Integer Exponents)

Explore for any integers a and b and for any exponents n , $(a \cdot b)^n = a^n \cdot b^n$ and $(a/b)^n = a^n / b^n$. (7 min)

Intro to Square Roots

Learn about the square root symbol (the principal root) and what it means to find a square root. (6 min)

Understanding Square Roots

Learn how square root means what number multiplied by itself will result in the given number. (1 min)

Square Root of Decimal

Learn how to find the square root of a decimal number. (3 min)

Intro to Cube Roots

Learn the meaning of cube roots and how to find them. Also learn how to find the cube root of a negative number. (8 min)

5th Roots

Learn about 5th roots and how to find them. (4 min)

Algebra | Exponential Growth & Decay

Intro to Exponential Functions

An exponential function represents the relationship between an input and output, where we use repeated multiplication on an initial value to get the output for any given input. (8 min)

Exponential vs. Linear Growth

For constant increments in x , a linear growth would increase by a constant difference, and an exponential growth would increase by a constant ratio. (3 min)

Exponential vs. Linear Models: Verbal

Explore how to look at the type of change over time to see if the given example represents linear or exponential growth. (3 min)

Exponential vs. Linear Models: Table

Determine whether real world model is linear or exponential, where the model is given as a table. (3 min)

Exponential Expressions Word Problems (Numerical)

Given the description of a real-world context, learn to write a calculation of a certain measure. (5 min)

Initial Value & Common Ratio of Exponential Functions

Explore how an exponential function of the form $f(x) = a \cdot b^x$, the initial value is usually taken to be the value of $f(0)$, or " a ". (5 min)

Exponential Expressions Word Problems (Algebraic)

Given a real-world context that involves repeated multiplication, model it with an exponential function. (3 min)

Interpreting Exponential Expression Word Problem

Given an exponential function that models a real-world context, interpret it to see what each part of the function represents in the real world. (3 min)

Exponential Function Graph

Learn to graph an exponential function, like $y = 5^x$, by picking a few inputs (x -values) and finding their corresponding outputs (y -values). (5 min)

Graphs of Exponential Growth

Identifying which graph represents a given exponential function. (4 min)

Exponential vs. Linear Growth Over Time

Compare linear and exponential growth and see that over time, *any* exponential growth will surpass *any* linear growth, no matter how steep it is. (5 min)

Exponential Decay Intro

Explore how in an exponential growth function, the factor is greater than 1, so the output will increase (or "grow") over time. - In an exponential decay function, the factor is between 0 and 1, so the output will decrease (or "decay") over time. (8 min)

Graphing Exponential Growth & Decay

Explore graphing the exponential functions $y=27 \cdot (\frac{1}{3})^x$ and $y=-30 \cdot 2^x$. (4 min)

Writing Functions with Exponential Decay

Explore how to write a function to model exponential decay in a context. (4 min)

Writing Exponential Functions

Learn to write the exponential function whose initial value is -2 and common ratio is $\frac{1}{7}$. (2 min)

Writing Exponential Functions from Tables

Explore the difference of a linear equation can be thought of as representing repeated addition on an initial value, while an exponential equation can be thought of as representing repeated multiplication on an initial value. (5 min)

Writing Exponential Functions from Graphs

Given a graph of an exponential curve, we can write an exponential function in the form $y=ab^x$ by identifying the common ratio (b) and y-intercept (a) in the graph. (7 min)

Analyzing Tables of Exponential Functions

Learn how to write an equation for an exponential function from a table of values: 1. (7 min)

Analyzing Graphs of Exponential Functions

Given the graph of an exponential function, find the formula of the function and a value that is outside the graph. (4 min)

Analyzing graphs of Exponential Functions: Negative Initial Value

Given the graph of an exponential function with a negative initial value, find the formula of the function and solve an equation. (6 min)

Modeling with Basic Exponential Functions Word Problem

Solve a word problem where he models the growth of a speeding ticket fine over time as an exponential function and then interprets this model. (6 min)

Linear vs. Exponential Growth: From Data (Example 1)

Construct functions that model the growth of trees over time and decide whether the function is linear or exponential. (6 min)

Linear vs. Exponential Growth: From Data (Example 2)

Construct a function that models cooling water and decides whether the function is linear or exponential. (7 min)

Algebra | Intro to Polynomials

Polynomials Intro

Polynomials are sums of terms of the form $k \cdot x^n$, where k is any number and n is a positive integer. For example, $3x+2x-5$ is a polynomial. (11 min)

Multiply Monomials by Polynomials:

Area Model

Use an area model to multiply a polynomial by a single term. (4 min)

Algebra | Multiplying Binomials

Multiplying Binomials: Area Model

Express the area of a rectangle whose height is $x+2$ and width is $x+3$. (4 min)

Multiplying Binomials Intro

Express $(x-4)(x+7)$ as the standard trinomial $x^2+3x-28$ and discusses how the general product $(x+a)(x+b)$ can be written as $x^2+(a+b)x+a \cdot b$. (5 min)

Multiplying Binomials

Express the product $(3x+2)(5x-7)$ as $15x^2-11x-14$. (6 min)

Special Products of the Form $(x+a)(x-a)$

Explore the difference of square expressions. For example, $(x+3)(x-3)$ is expanded as x^2-9 . (5 min)

Squaring Binomials of the Form $(x+a)^2$

Explore the perfect square expressions. For example, $(x+7)^2$ is expanded as $x^2+14x+49$. (6 min)

Special Products of the Form

$(ax+b)(ax-b)$

Explore the difference of squares $(2x+8)(2x-8)$ as $4x^2-64$. (4 min)

Squaring Binomials of the Form $(ax+b)^2$

Explore the perfect square $(7x+10)^2$ as $49x^2+140x+100$. (3 min)

Algebra | Factoring Quadratics

Intro to Factors & Divisibility

Discover what it means for a polynomial to be a factor of another polynomial, and what it means for a polynomial to be divisible by another polynomial. (5 min)

Factoring with the Distributive Property

Explore how to factor the expression $4x+18$ into the expression $2(2x+9)$. (3 min)

Factoring Quadratics as $(x+a)(x+b)$ **(Example 1)**

Factor $x^2-3x-10$ as $(x+2)(x-5)$ using the sum-product form: $(x+a)(x+b)=x^2+(a+b)x+a*b$.

(6 min)

Factoring Quadratics as $(x+a)(x+b)$ **(Example 2)**

Factor $x^2-14x+40$ as $(x-4)(x-10)$ and x^2-x-12 as $(x+3)(x-4)$. (4 min)

More Examples of Factoring Quadratics as $(x+a)(x+b)$

Explore these different examples of factoring. (16 min)

Factoring Quadratics with a Common Factor

Learn to factor quadratics by first pulling out a common factor so the result looks like

$a(x+b)(x+c)$. (3 min)

Factoring Completely with a Common Factor

Learn to factor quadratics by first pulling out a common factor so the result looks like

$a(x+b)(x+c)$. (4 min)

Intro to Grouping

Explore the method of grouping, which is very useful in factoring quadratics who's leading coefficient is not 1. (14 min)

Factoring Quadratics by Grouping

Factor $4y^2+4y-15$ as $(2y-3)(2y+5)$ by grouping. (4 min)

Factoring Quadratics: Common Factor + Grouping

Factor $35k^2+100k-15$ as $5(k+3)(7k-1)$. (5 min)

Factoring Quadratics: Negative Common Factor + Grouping

Factor $-12f^2-38f+22$ as $-2(2f-1)(3f+11)$. (5 min)

Difference of Squares Intro

Learn that when an expression can be viewed as the difference of two perfect squares, i.e. a^2-b^2 , then we can factor it as $(a+b)(a-b)$.

(5 min)

Factoring Difference of Squares: Leading Coefficient $\neq 1$

Factor $45x^2-125$ as $5(3x+5)(3x-5)$. (2 min)

Factoring Difference of Squares: Analyzing Factorization

Analyze the two different factorizations of $16x^2-64$ and determine whether they are correct. (3 min)

Factoring Difference of Squares: Shared Factors

Find the binomial factor shared by $m^2-4m-45$ and $6m^2-150$. (4 min)

Perfect Square Factorization Intro

Learn when an expression has the general form $a^2+2ab+b^2$, then we can factor it as $(a+b)^2$. (5 min)

Factoring Perfect Squares

Factor $25x^2-30x+9$ as $(5x-3)^2$ or as $(-5x+3)^2$. (5 min)

Identifying Perfect Square Form

Explore how we can identify that a trinomial has the "perfect square" form.

(4 min)

Factoring Perfect Squares: Negative Common Factor

Learn to factor $-4t^2-12t-9$ as $-1(2t+3)^2$. (4 min)

Factoring Perfect Squares: Missing Values

Analyze the factorization of x^2+5x+c as $(x+d)^2$ to find the values of the missing coefficients c and d . (3 min)

Factoring Perfect Squares: Shared Factors

Find the binomial factor shared by $4x^2+12x+9$ and $4x^2-9$. (5 min)

Strategy in Factoring Quadratics (Part 1)

Explore how to think strategically about which method is useful for a given quadratic expression we want to factor. (7 min)

Strategy in Factoring Quadratics (Part 2)

Explore how to think strategically about which method is useful for a given quadratic expression we want to factor. (8 min)

Algebra | Intro to Parabolas

Parabolas Intro

Learn and explore all about parabolas and their shared characteristics. (8 min)

Interpreting a Parabola in Context

Given a parabola that models a context, learn to relate key features of the parabola, like the y-intercept, vertex, and x-intercepts. (3 min)

Interpret a Quadratic Graph

Interpret what the features of a graph of a quadratic model mean in terms of a given context. (3 min)

Algebra | Quadratics in Factored Form & Vertex Form

Zero Product Property

Learn that the zero product property states that if $a \cdot b = 0$ then either a or b equal zero. (7 min)

Graphing Quadratics in Factored Form

Analyze the quadratic function in factored form to find the x-intercepts of the graph as well as the vertex. (6 min)

Quadratic Word Problems (Factored Form)

Solve a problem where a quadratic function (given in factored form) models the height of a launched rocket. (6 min)

Vertex Form Introduction

Discover one of the common forms for quadratic functions is called vertex form, because it highlights the coordinates of the vertex of the function's graph. (6 min)

Graphing Quadratics: Vertex Form

Learn how to graph any quadratic function that is given in vertex form. (4 min)

Quadratic Word Problems (Vertex Form)

Given a quadratic function that models the height of an object being launched from a platform, analyze the function to answer questions like "what is the height of the platform?" or "when does the object reach its maximum height?". (7 min)

Algebra | Solving Quadratics by Taking the Square Root

Solving Quadratics by Taking Square Roots

Solve the equation $2x^2+3=75$ by isolating x^2 and taking the square root of both sides. (3 min)

Solving Quadratics by Taking Square Roots Examples

Solve the equation $(x+3)^2-4=0$ and finds the x-intercepts of $f(x)=(x-2)^2-9$. (5 min)

Quadratics by Taking Square Roots: Strategy

Analyze a given solution of a quadratic equation and find where and what was the error in that process. (2 min)

Solving Quadratics by Taking Square Roots: With Steps

Explore the exact order of steps in the process of solving the equation $3(x+6)^2=75$. (4 min)

Algebra | Solving Quadratics by Factoring

Solving Quadratics by Factoring

Solve the equation $s^2-2s-35=0$ by factoring the expression on the left as $(s+5)(s-7)$ and finding the s-values that make each factor equal to zero. (6 min)

Solving Quadratics by Factoring: Leading Coefficient $\neq 1$

Solve $6x^2-120x+600=0$ by first dividing by 6 and then factoring. (4 min)

Solving Quadratics Using Structure

Solve $(2x-3)^2=4x-6$ by substituting p for $2x-3$ and obtaining the simpler equation $p^2=2p$. (4 min)

Quadratic Equations Word Problem: Triangle Dimensions

Solve a geometry problem using a quadratic equation. (8 min)

Quadratic Equations Word Problem: Box Dimensions

Solve a volume problem using a quadratic equation. (6 min)

Algebra | The Quadratic Formula

The Quadratic Formula

Learn about the quadratic formula and how it helps us solve any quadratic equation. (17 min)

Worked Example: Quadratic Formula

Solve the equation $-x^2+8x=1$ by first bringing it to standard form and then using the quadratic formula. (7 min)

Worked Example: Quadratic Formula (Negative Coefficients)

Solve $-3x^2+10x-3=0$ by plugging $a=-3$, $b=10$, $c=-3$ in the quadratic formula. (5 min)

Using the Quadratic Formula: Number of Solutions

Determine how many solutions the equation $x^2+14x+49=0$ has by considering its quadratic formula, and more specifically, its discriminant. (5 min)

Strategy in Solving Quadratic Equations

Based on the initial form of a quadratic equation, determine which solution methods are and aren't appropriate. (6 min)

Algebra | Completing the Square

Completing the Square

Learn how to "complete the square" by adding a constant number to a quadratic expression. (14 min)

| Worked Example: Completing the Square (Intro)

Discover how to complete x^2-44x into a perfect square. (3 min)

Worked Example: Rewriting Expressions by Completing the Square

Learn to rewrite $x^2+16x+9$ as $(x+8)^2-55$ by completing the square. (3 min)

Worked Example: Rewriting & Solving

Equations by Completing the Square

Solve $x^2 - 2x - 8 = 0$ by rewriting the equation as $(x-1)^2 - 9 = 0$ by completing the square. (6 min)

Solve by Completing the Square: Integer Solutions

Use the strategy of completing the square to solve quadratic equations (6 min)

Solve by Completing the Square: Non-Integer Solutions

Use the strategy of completing the square to solve quadratic equations even when the solutions aren't integers. (4 min)

Worked Example: Completing the Square (Leading Coefficient $\neq 1$)

Solve the equation $4x^2 + 40x - 300 = 0$ by completing the square. (5 min)

Solving Quadratics by Completing the Square: No Solution

Try to solve the equation $4x^2 + 40x + 280 = 0$ by completing the square, only to find there's no solution for this equation. (5 min)

Proof of the Quadratic Formula

Prove the quadratic formula using the method of completing the square. (8 min)

Algebra | Features & Forms of Quadratic Functions

Finding the Vertex of a Parabola in Standard Form

Rewrite the equation $y = -5x^2 - 20x + 15$ in vertex form (by completing the square) to identify the vertex of the corresponding parabola. (8 min)

Graphing Quadratics: Standard Form

Learn how to graph any quadratic function that is given in standard form. (6 min)

Quadratic Word Problem: Ball

Solve a word problem about a ball being shot in the air. (6 min)

Forms & Features of Quadratic Functions

Rewrite $f(x) = x^2 - 5x + 6$ in factored form to reveal its zeros and in vertex form to reveal its vertex. (6 min)

Worked Examples: Forms & Features of Quadratic Functions

Learn to choose whether factored form, vertex form or standard form of a quadratic is best in different situations. (7 min)

Vertex & Axis of Symmetry of a Parabola

Rewrite a quadratic equation in vertex form and shows how it reveals the vertex of the corresponding parabola. (7 min)

Finding Features of Quadratic Functions

Find the zeros, the vertex, & the line of symmetry of quadratic functions given in vertex form, factored form, & standard form. (8 min)

Interpret Quadratic Models: Factored Form

Given a quadratic function that models a relationship, rewrite the function to reveal certain properties of the relationship. (4 min)

Interpret Quadratic Models: Vertex Form

Given a quadratic function that models a relationship, rewrite the function to reveal certain properties of the relationship. (6 min)

Algebra | Comparing & Transforming Quadratic Functions

Comparing Features of Quadratic Functions

Compare the y-intercepts, the zeros, and the concavity of quadratic functions given graphically and algebraically. (4 min)

Comparing Maximum Points of Quadratic Functions

Given several quadratic functions represented in different forms, find the one with the lowest maximum value. (4 min)

Intro to Parabola Transformations

Discuss how we can shift and scale the graph of a parabola to obtain any other parabola, and how this affects the equation of the parabola. (8 min)

Shifting Parabolas

Explore how the graph of $y = (x-k)^2 + h$ is the resulting of shifting (or translating) the graph of $y = x^2$, k units to the right and h units up. (5 min)

Scaling & Reflecting Parabolas

Find the equation of a parabola from its graph. (5 min)

Algebra | Irrational Numbers

Intro to Rational & Irrational Numbers

Learn the difference between rational and irrational numbers, learn how to identify them, and discover why some of the most famous numbers in mathematics, like π and e , are actually irrational. (6 min)

Classifying Numbers: Rational & Irrational

Learn to write any rational number as the ratio of two integers, and learn that irrational numbers, such as the square root of 8 and π , cannot be written this way. (3 min)

Proof: Sum & Product of Two Rationals is Rational

Prove that the sum, or the product, of any two rational numbers will always be a rational number. (3 min)

Proof: Product of Rational & Irrational is Irrational

Learn that the product of any rational number and any irrational number will always be an irrational number. (3 min)

Proof: Sum of Rational & Irrational is Irrational

Learn that the sum of any rational number and any irrational number will always be an irrational number. (3 min)

Sums and Products of Irrational Numbers

Explore how the sum of two irrational numbers can be rational and it can be irrational. (6 min)

Worked Example: Rational vs. Irrational Expressions

Show how to determine whether the following expressions are rational or irrational: $9 + \sqrt{45}$, $\sqrt{45}/(3\sqrt{5})$, and $3\sqrt{9}$. (3 min)

Worked Example: Rational vs. Irrational Expressions (Unknowns)

Determine whether expressions with unknown rational/irrational numbers are rational or irrational. (6 min)

Proof: $\sqrt{2}$ is Irrational

Prove that the square root of 2 is an irrational number, i.e. it cannot be given as the ratio of two integers. (8 min)

Proof: Square Roots of Prime Numbers are Irrational

Prove that the square root of any prime number must be an irrational number. (8 min)

Proof: There's an Irrational Number Between Any Two Rational Numbers

Prove that when given any two rational numbers, no matter how close, we can find an irrational number that lies between them. (6 min)

Geometry

Intro to Euclidean Geometry

Euclid as the Father of Geometry

Euclid, often called the father of geometry, changed the way we learn about shapes with his 13-book series, Euclid's Elements. He used basic ideas called axioms or postulates to create solid proofs and figure out new ideas called theorems and propositions. (8 min)

Terms & Labels in Geometry

Learn key geometric terms like colinear points, midpoints, and vertices, and enhance your knowledge of geometry. (13 min)

Geometric Definitions Example

Explore using precise language is important in geometry, as it allows for clear communication and understanding of geometric concepts. (9 min)

Intro to Rigid Transformations

Rigid Transformations Intro

Transformations in math involve changing a shape's position or which way the shape points. There are three main types: translations (moving the shape), rotations (turning the shape), and reflections (flipping the shape like a mirror image). Rigid transformations keep the shape's size and angles the same. (7 min)

Dilations Intro

Dilations are a type of non-rigid transformation. They change the size of a shape by scaling it up or down, making it bigger or smaller. Unlike rigid transformations, dilations do not keep the shape's size the same. (2 min)

Identifying Transformations

Explore the four types of transformations: rotations (spinning a shape around a point), translations (shifting a shape), reflections (flipping a shape over a line), and dilations (shrinking or expanding a shape). (4 min)

Translations

Translating Points

Explore how a translation is a way to move a point or shape by a certain number of units in a certain direction. (4 min)

Determining Translations

Learn to find the translation by figuring out how much the x- and y-coordinates need to change to map one triangle onto the other. (2 min)

Translating Shapes

Explore how in translations we move every point of the shape a certain distance left or right, and up or down, to create a new shape that's the same size and shape as the original. (2 min)

Challenge Problem: Translation

Explore the translation acting on the coordinate plane takes the point $(-169, 434)$ to point $(-203, -68)$. (3 min)

Rotations

Rotating Points

Explore the different rotation angles and how positive angles rotate counterclockwise and negative angles rotate clockwise. (2 min)

Determining Rotations

Learn to see the angle of rotation, we draw lines from the center to the same point in the shape before and after the rotation. (3 min)

Rotating Shapes

Given a triangle on the coordinate plane and the definition of a rotation about the origin, manually draws the image of that rotation. (8 min)

Reflections

Reflecting Points

Reflections create mirror images of points, keeping the same distance from the line. When we reflect across the y-axis, the image point is the same height but has the opposite position from left to right. (4 min)

Determining Reflections

Learn about how a line of reflection is an imaginary line that flips one shape onto another. (2 min)

Determining Reflections (Advanced)

Given two line segments on the coordinate plane, determine the reflection that maps one of them into the other. (6 min)

Reflecting Shapes

Explore how to reflect a quadrilateral across the x-axis. (3 min)

Reflecting Shapes: Diagonal Line of Reflection

Given two line segments on the coordinate plane and the definition of a reflection, draw the image of the segments under that reflection. (7 min)

Dilations

Dilating Points

Dilations are a way to stretch or shrink shapes around a point called the center of dilation. The amount we stretch or shrink is called the scale factor. If the scale factor is greater than 1, the shape stretches. If it's between 0 and 1, the shape shrinks. (3 min)

Dilations: Scale Factor

A scale factor tells us how much to multiply by the side lengths to change the size. The scale factor is the ratio of the side length in the new shape (image) to the side length in the corresponding side in the original shape (pre-image). (5 min)

Dilations: Center

Determining the center of dilation, given a figure and its image under a dilation. (3 min)

Dilating Shapes: Expanding

Let's dilate a rectangle around a point P using a scale factor $1\frac{2}{3}$. This changes the size of the rectangle while keeping its shape. Because $1\frac{2}{3}$ is bigger than 1, most of the points get farther from P. Point P stays in place, because a distance of 0 times any scale factor is still 0. (3 min)

Dilating Shapes: Shrinking

Draw the image of the triangle under a dilation with scale factor $\frac{1}{4}$ about the center of dilation on the coordinate plane. (3 min)

Dilating Triangles: Find the Error

Explore that dilating doesn't just shrink or grow a figure. The scale factor also changes the distance from each point to the center of dilation. (3 min)

Properties of Transformations

Finding Measures Using Rigid Transformations

Learn how to find the measures after a rigid transformation. (5 min)

Rigid Transformations:

Preserved Properties

Rigid transformations preserve side lengths, angle measures, perimeter, and area, but they might not keep the same coordinates or relationships to lines outside the figure. (7 min)

Mapping Shapes

Find the right sequence of rigid transformations (like rotations, translations, and reflections) to map one triangle onto another. (9 min)

Dilations and Properties

Learn what properties of a shape are preserved or not preserved after a dilation. (6 min)

Sequences of Transformations

Determine whether segment lengths and angle measures are preserved under a given sequence of transformations. (4 min)

Defining Transformations

Given a description of the effect of a certain transformation, determine whether that transformation is a translation, a rotation, or a reflection. (6 min)

Identifying Type of Transformation

Determine what kind of transformation when given information in terms of a few pairs of points and their corresponding images. (5 min)

Proofs with Transformations

Explore this exercise about line and angle proofs. (9 min)

Symmetry

Intro to Reflective Symmetry

Discover the concept of an "axis of symmetry". (3 min)

Intro to Rotational Symmetry

Explore whether various figures are symmetrical under a 180 degrees rotation. (4 min)

Finding a Quadrilateral from its Symmetries (Example 1)

Draw and classify the quadrilateral. (3 min)

Finding a Quadrilateral from its Symmetries (Example 2)

Two of the points that define a certain quadrilateral are $(-4, -2)$ and $(0, 5)$. The quadrilateral has a reflective symmetry over the lines $y = x/2$ and $y = -2x + 5$. Draw and classify the quadrilateral. (7 min)

Intro to Congruence

Congruent Shapes & Transformations

Explore the differences between congruent shapes and transformations. (2 min)

Non-Congruent Shapes & Transformations

Learn what makes a shape non-congruent and how transformations affect congruency. (2 min)

Segment Congruence Equivalent to Having Same Length

Discover how two-line segments are congruent if and only if they have equal lengths. (7 min)

Angle Congruence Equivalent to Having Same Measure

Discover how two angles are congruent if and only if they have the same measure. (6 min)

Congruent Triangles

Corresponding Parts of Congruent Triangles are Congruent

Discover that when two triangles are congruent, that all their corresponding sides and angles are congruent too. (6 min)

Proving the SSS Triangle Congruence Criterion Using Transformations

Prove the side-side-side (SSS) triangle congruence criterion using the rigid transformation definition of congruence. (6 min)

Proving the SAS Triangle Congruence Criterion Using Transformations

Prove the side-angle-side (SAS) triangle congruence criterion using the rigid transformation definition of congruence. (4 min)

Proving the ASA and AAS Triangle Congruence Criteria Using Transformations

Prove the angle-side-angle (ASA) and angle-angle-side (AAS) triangle congruence criteria using the rigid transformation definition of congruence. (7 min)

Why SSA isn't a Congruence Postulate/Criterion

There are some cases when SSA can imply triangle congruence, but not always. This is why it's not like the other triangle congruence postulates/criteria. (7 min)

Triangle Congruence Postulates/Criteria

Explore and justify the SSS, SAS, ASA and AAS postulates for congruent triangles. (14 min)

Determining Congruent Triangles

Use the SSS, ASA, SAS, and AAS postulates to find congruent triangles. (7 min)

Calculating Angle Measures to Verify Congruence

Calculate missing angle measures to determine which triangles must be congruent. (4 min)

Proving Triangle Congruence

Given a figure composed of 2 triangles, prove that the triangles are congruent or determine that there's not enough information to tell. (4 min)

Proofs & Properties of Triangles

Angles in a Triangle Sum to 180° Proof

Learn to use transversals, vertical angles, and corresponding angles to rearrange those angle measures into a straight line, proving that they must add up to 180. (4 min)

Proofs Concerning Isosceles Triangles

Prove that the base angles in isosceles triangles are congruent, and conversely, that triangles with congruent base angles are isosceles. (9 min)

Proofs Concerning Equilateral Triangles

Prove that the angles of an equilateral triangle are all congruent (and therefore they all measure 60°), and conversely, that triangles with all congruent angles are equilateral. (7 min)

Triangle Exterior Angle Example

Explore that an exterior angle is formed outside a triangle by extending a side. Its measure is equal to the sum of the two non-adjacent interior angle measures, thanks to the fact that all angle measures in a triangle add up to 180 degrees. (6 min)

Corresponding Angles in Congruent Triangles

Use the Letters of congruent triangles to solve some angles. (4 min)

Isosceles & Equilateral Triangles Problems

Isosceles triangles have two congruent sides and two congruent base angles. Equilateral triangles have all side lengths equal and all angle measures equal. We use these properties to find missing angles in composite figures. (6 min)

Finding Angles in Isosceles Triangles (Example 1)

The measures of two angles of an isosceles triangle are $3x+5$ and $x+16$. Find all possible values of x . (6 min)

Finding Angles in Isosceles Triangles (Example 2)

Explore how isosceles triangles and parallel lines with the power of algebra to solve the angles of an isosceles triangle. (4 min)

Proofs & Properties of Quadrilaterals

Proof: Opposite Sides of a Parallelogram

Prove that a figure is a parallelogram if and only if opposite sides are congruent. (8 min)

Proof: Diagonals of a Parallelogram

Discover that a quadrilateral is a parallelogram if and only if its diagonals bisect each other. (9 min)

Proof: Opposite Angles of a Parallelogram

Discover that opposite angles of a parallelogram are congruent. (4 min)

Proof: The Diagonals of a Kite are Perpendicular

Discover that the diagonals of a kite are perpendicular, by using the SSS and SAS triangle congruence criteria. (11 min)

Proof: Rhombus Diagonals are Perpendicular Bisectors

Discover that the diagonals of a rhombus are perpendicular, and that they intersect at the midpoints of both. (4 min)

Proof: Rhombus Area

Discover that we can find the area of a rhombus by taking half the product of the lengths of the diagonals. (5 min)

Proofs of General Theorems

Geometry Proof Problem: Midpoint

Discover that a point is the midpoint of a segment using triangle congruence. (6 min)

Geometry Proof Problem: Congruent Segments

Prove that two pairs of segments are congruent using the ASA and AAS congruence criteria. (12 min)

Geometry Proof Problem: Squared Circle

Find a missing angle using triangle congruence in a diagram that contains sectors of a circle inscribed within a square. (8 min)

Constructing Lines & Angles

Geometric Constructions: Congruent Angles

Explore how to construct congruent angles with a compass and straight edge. They're congruent corresponding angles of congruent triangles. (4 min)

Geometric Constructions: Parallel Line

Explore how to construct parallel lines with compass and straightedge by creating a pair of congruent corresponding angles on a transversal. (2 min)

Geometric Constructions: Perpendicular Bisector

Explore how to construct a perpendicular bisector to a given line segment using compass and straightedge. (2 min)

Geometric Constructions: Perpendicular Line Through a Point on the Line

Explore how to construct a line perpendicular to a given line through a point on the line using compass and straightedge. (1 min)

Geometric Constructions: Perpendicular Line Through a Point Not on the Line

Learn to construct a perpendicular line through a point off the line. The lines must be perpendicular because a rhombus's diagonals are perpendicular. (3 min)

Geometric Constructions: Angle Bisector

Learn to construct a line that bisects a given angle using compass and straightedge. (2 min)

Similar Triangles

Similar Shapes & Transformations

Explore how two shapes are similar after they have gone through transformation and what makes shapes not similar. (2 min)

Intro to Triangle Similarity

Discover what it means for triangles to be similar, and how this follows from the definition of similarity (9 min)

Triangle Similarity Postulates/Criteria

Explore all the different ways we can determine that two triangles are similar. (12 min)

Determining Similar Triangles

Analyze multiple examples of the similarity of triangles. (9 min)

Solving Similar Triangles

Solve two problems where a missing side length is found by proving that triangles are similar and using this to find the measure. (7 min)

Solving Similar Triangles: Same Side Plays Different Roles

Find a missing side length in a problem where the same side plays different roles in two similar triangles. (6 min)

Intro to Angle Bisector Theorem

The angle bisector theorem states that when an angle in a triangle is split into two equal angles, it divides the opposite side into two parts. The ratio of these parts will be the same as the ratio of the sides next to the angle. (8 min)

Using the Angle Bisector Theorem

Use the angle bisector theorem to solve for the sides of a triangle. (3 min)

Using Similar & Congruent Triangles

Use the similarity of triangles and the congruence of others in this multi-step problem to find the area of a polygon. (10 min)

Challenge Problem: Triangle Similarity

Learn to solve a similarity problem where we don't have a lot of information to work with. (10 min)

Proofs & Problem-Solving with Similar Triangles

Pythagorean Theorem Proof Using Similarity

Explore the Pythagorean theorem using similarity. (10 min)

Exploring Medial Triangles

The three midsegments (segments joining the midpoints of the sides) of a triangle form a medial triangle. Find out the properties of the midsegments, the medial triangle and the other 3 triangles formed in this way. (12 min)

Proof: Parallel Lines Divide Triangle Sides Proportionally

Discover that a line parallel to one triangle side divides other sides proportionately. (7 min)

Proving Slope is Constant Using Similarity

Use a clever proof involving similar triangles to show that slope is constant for a line. (8 min)

Proof: Parallel Lines have the Same Slope

Discover that parallel lines have the same slope using triangle similarity. (6 min)

Proof: Perpendicular Lines have Opposite Reciprocal Slopes

Learn to prove that perpendicular lines have opposite reciprocal slopes, draw the two lines and label key points. (9 min)

Geometry Word Problem: The Golden Ratio

Solve this word problem about triangle similarity, the golden ratio, and art. (9 min)

Geometry Word Problem: Earth & Moon Radii

Solve this word problem about triangle similarity, the golden ratio, and the Earth. (7 min)

Geometry Word Problem: A Perfect Pool Shot

Use triangle similarity to plan the perfect shot in a pool game. (7 min)

Pythagorean Theorem & Its Proofs

Pythagorean Theorem in 3D

Discover how to find the length of an edge in a 3D shape using the Pythagorean theorem. (6 min)

Pythagorean Theorem with Isosceles Triangle

Find the value of a base (x) in an isosceles triangle by using the Pythagorean theorem to create an equation involving x . (4 min)

Multi-Step Word Problem with Pythagorean Theorem

Use the Pythagorean theorem and proportional reasoning in context. (5 min)

Pythagorean Theorem Proof Using Similarity

Explore this proof of the Pythagorean theorem using similarity. (10 min)

Special Right Triangles & Ratios

Special Right Triangles: 30-60-90

Learn how to prove the ratios between the sides of a 30-60-90 triangle. (7 min)

Special Right Triangles: 45-45-90

Showing the ratios of the sides of a 45-45-90 triangle are $1:1:\sqrt{2}$. (6 min)

30-60-90 Triangle Example Problem

Use 30-60-90 triangles to solve what at first seems to be a challenging problem. (7 min)

Area of a Regular Hexagon

Find the area of a regular hexagon. (8 min)

Using Similarity to Estimate Ratio

Between Side Lengths

When two right triangles share an acute angle measure, the ratios of the corresponding side lengths within the triangles are equal. (5 min)

Using Right Triangle Ratios to Approximate Angle Measure

Because of similarity, all right triangles with a given acute angle measure have equal ratios between their side lengths. (3 min)

Intro to Trigonometric Ratios

Triangle Similarity & the Trigonometric Ratios

Explore how the trigonometric ratios are derived from triangle similarity considerations. (9 min)

Trigonometric Ratios in Right Triangles

Use the two legs of a right triangle to find the trig ratios of one of the acute angles. (12 min)

Solving for a Side in Right Triangles with Trigonometry

Given a right triangle with an acute angle of 65° and a leg of 5 units, uses trigonometry to find the two missing sides (7 min)

Sine & Cosine of Complementary Angles

Show that the sine of any angle is equal to the cosine of its complementary angle. (4 min)

Using Complementary Angles

Solve the following problem: Given that $\cos(58^\circ)=0.53$, find $\sin(32^\circ)$. (4 min)

Trig Word Problem: Complementary Angles

Solve a problem about a submerged pyramid using the fact that the sine of an angle is equal to the cosine of its complementary angle. (6 min)

Trig Challenge Problem: Trig Values & Side Ratios

Match different expressions with different trig values. (10 min)

Right Triangle Word Problem

Solve a modeling problem where he finds the necessary angle to shoot at a vicious alien. (4 min)

Analyzing Line Segments

Distance Formula

Learn how to find the distance between two points by using the distance formula, which is an application of the Pythagorean theorem. (9 min)

Midpoint Formula

Learn how to use the midpoint formula to find the midpoint of a line segment on the coordinate plane or find the endpoint of a line segment given one point and the midpoint. (7 min)

Dividing Line Segments: Graphical

Figure out the coordinates of a point between two other points that give a certain ratio. (5 min)

Dividing Line Segments

Figure out the coordinates of a point between two other points that give a certain ratio. (4 min)

Proving Triangle Medians Intersect at a Point

Prove that for any triangle, the medians intersect at a point $\frac{2}{3}$ of the way from each vertex to the midpoint of the opposite side. (7 min)

Problem-Solving on the Coordinate Plane

Area of Trapezoid on the Coordinate Plane

Find the area of a trapezoid using the distance formula and the trapezoid area formula. (7 min)

Points Inside/Outside/On a Circle

Use the distance formula to determine whether the point $(-6,-6)$ is inside, outside, or on the circle centered at $(-1,-3)$ with radius 6. (4 min)

Challenge Problem: Points on Two Circles

Solve a challenging problem where he must determine if points are on both, one, or neither of two circles. (10 min)

Coordinate Plane Word Problem

Solve an example where must determine which of the Minions a wizard can reach using the coordinate plane. (6 min)

Parallel & Perpendicular Lines Intro

Learn how to identify parallel and perpendicular lines. (2 min)

Parallel & Perpendicular Lines from Graph

Determine whether given lines are parallel or perpendicular. (7 min)

Classifying Quadrilaterals on the Coordinate Plane

Classify a quadrilateral as a square, rhombus, rectangle, parallelogram, or trapezoid given its four vertices. (5 min)

Classifying Figures with Coordinates

Use coordinates to determine the slopes of sides of a figure to classify it. (7 min)

Equations of Parallel & Perpendicular Lines

Parallel Lines from Equation (Example 1)

Determine which pairs out of a few given linear equations are parallel. (4 min)

Parallel Lines from Equation (Example 2)

Determine which pairs out of a few given linear equations are parallel. (3 min)

Parallel Lines from Equation (Example 3)

Determine which pairs out of a few given linear equations are parallel. (3 min)

Perpendicular Lines from Equation

Determine which pairs out of a few given linear equations are perpendicular. (3 min)

Writing Equations of Perpendicular Lines (Example 1)

Given line A and point P, find the equation of the line perpendicular to A that passes through P. (3 min)

Writing Equations of Perpendicular Lines (Example 2)

Find the equation of a line perpendicular to a line given in slope-intercept form that passes through a specific point. (2 min)

Proof: Parallel Lines have the Same Slope

Prove that parallel lines have the same slope using triangle similarity. (6 min)

Proof: Perpendicular Lines have Opposite Reciprocal Slopes

Explore how to show that two slopes are indeed opposite reciprocals of each other. (9 min)

Conic Sections

Intro to Conic Sections

Discover the four conic sections and show how they are derived by intersecting planes with cones in certain ways. (11 min)

Graphing Circles from Features

Learn to graph a circle given the center and either the radius or another point on the circle. (2 min)

Features of a Circle from its Graph

Given a circle on the coordinate plane, find its center and its radius. (4 min)

Features of a Circle from its Standard Equation

Find the center and the radius of the circle whose equation is $(x+3)^2+(y-4)^2=49$. (4 min)

Graphing a Circle from its Standard Equation

Graph the circle whose equation is $(x+5)^2+(y-5)^2=4$. (6 min)

Writing Standard Equation of a Circle

Given a circle on the coordinate plane, find its standard equation, which is an equation in the form $(x-a)^2+(y-b)^2=r^2$. (6 min)

Features of a Circle from its Expanded Equation

Find the center and the radius of a circle whose equation is $x^2+y^2+4x-4y-17=0$, and then graph the circle. (4 min)

Intro to Focus & Directrix

Learn how a parabola is the set of all points equidistant from a point (called the "focus") and a line (called the "directrix"). (4 min)

Equation of a Parabola from Focus & Directrix

The equation of a parabola is derived from the focus and directrix, and then the general formula is used to solve an example. (10 min)

Circle Basics

Circles Glossary

Discover the formal definition of a circle, Tangent and secant lines, Diameters and radii, major and minor arcs. (11 min)

Area of a Circle Intuition

Use triangles to create an informal argument for the area of a circle formula. (9 min)

Proof: All Circles are Similar

Explore that all circles are similar by showing how we can translate then dilate any circle onto another. (2 min)

Arc Measure, Arc Length, & Sectors

Intro to Arc Measures

Learn about arc measures including that they must sum to 360, conventions of minor and major arcs, and a comparison to arc length. (6 min)

Finding Arc Measures

Solve a few problems where he finds a missing arc measure. (6 min)

Finding Arc Measures with Equations

Solve a few items where arc measures are given in equations, we must find a variable, then use it to find an arc measure. (7 min)

Arc Length from Subtended Angle

Find the length of an arc using the degree of the angle subtended by the arc and the perimeter of the circle. (5 min)

Subtended Angle from Arc Length

Solve an example where he finds the central angle given arc length. (2 min)

Area of a Sector

Find the area of a circle's sector using the area of the circle and the central angle of the sector. (2 min)

Radians as Ratio of Arc Length to Radius

Derive using similarity the fact that the length of the arc intercepted by an angle is proportional to the radius and define the radian measure of the angle as the constant of proportionality. (7 min)

Intro to Radians

Intro to Radians

Explore the definition and motivation for radians and the relationship between radians and degrees. (11 min)

Radians & Degrees

Discover the general approach to converting between radians and degrees and vice versa. (7 min)

Degrees to Radians

Learn how to convert from degrees to radians by multiplying the number of degrees by $\pi/180$. (7 min)

Radians to Degrees

Learn to change from radians to degrees by multiplying the number of radians by $180/\pi$. (3 min)

Arc Length as Fraction of Circumference

Find the fraction of an arc length out of the entire circumference using the radian measure of the central angle subtended by the arc. (3 min)

Arc Length from Subtended Angle: Radians

Find the length of an arc using the radius and the radian measure of the angle subtended by the arc. (3 min)

Inscribed Angles & Shapes

Inscribed Angles

Find a missing inscribed angle using the inscribed angle theorem. (1 min)

Inscribed Angle Theorem Proof Prove that an inscribed angle is half of a central angle that subtends the same arc. (14 min)

Inscribed Shapes: Find Diameter

Find the diameter of a circle using an inscribed right triangle. (2 min)

Inscribed Shapes: Angle Subtended by Diameter

Explore one method using an inscribed angle intercepting a diameter of a circle. (6 min)

Inscribed Shapes: Find Inscribed Angle

Explore using either the inscribed angle theorem or the fact that two inscribed angles that intercept the same arc must be congruent. (2 min)

Solving Inscribed Quadrilaterals

Explore supplementary opposite angles in inscribed quadrilateral. (5 min)

Proof: Right Triangles Inscribed in Circles

Explore this proof showing that a triangle inscribed in a circle having a diameter as one side is a right triangle. (5 min)

Inscribed Quadrilaterals Proof

Use the inscribed angle theorem and some algebra to prove that opposite angles of an inscribed quadrilateral are supplementary. (4 min)

Properties of Tangents

Proof: Radius is Perpendicular to a Chord it Bisects

Prove that if a radius in a circle is drawn so it bisects a chord, then the radius is also perpendicular to that chord. The proof uses SSS congruence. (8 min)

Proof: Perpendicular Radius Bisects Chord

Explore this simple proof using right triangle-side-hypotenuse (RSH) congruence criterion to show that a radius perpendicular to a chord bisects it. (4 min)

Proof: Radius is Perpendicular to Tangent Line

Prove that the radius that connects the intersection point of a tangent line with the circle is perpendicular to the tangent line. (9 min)

Proof: Segments Tangent to Circle from Outside Point are Congruent

Prove that two tangent segments to a circle that are drawn from the same outside point are congruent. (4 min)

Tangents of Circles Problem (Example 1)

Find missing angles using the property that tangents are perpendicular to the radius. (4 min)

Tangents of Circles Problem (Example 2)

Find a missing angle using the property that tangents are perpendicular to the radius. (4 min)

Tangents of Circles Problem (Example 3)

Find a missing length using the property that tangents are perpendicular to the radius. (3 min)

Geometric Constructions:

Circle Tangent (Example 1)

Construct a line tangent to a circle using compass and straightedge. (6 min)

Geometric Constructions:

Circle Tangent (Example 2)

Construct a line tangent to a circle using compass and straightedge. (5 min)

Constructing Inscribed & Circumscribed Shapes

Geometric Constructions: Circle-Inscribed Square

Construct a square that is inscribed inside a given circle using compass and straightedge. (3 min)

Geometric Constructions: Circle-Inscribed Equilateral Triangle

Construct an equilateral triangle that is inscribed inside a given circle using compass and straightedge. (4 min)

Geometric Constructions: Circle-Inscribed Regular Hexagon

Construct a regular hexagon that is inscribed inside a given circle using compass and straightedge. (4 min)

Geometric Constructions: Triangle-Inscribing Circle

Construct a circle that inscribes a given triangle using compass and straightedge. (3 min)

Geometric Constructions: Triangle-Circumscribing Circle

Construct a circle that circumscribes a given triangle using compass and straightedge. (2 min)

2D vs. 3D Objects

Dilating in 3D

The cross sections of 3D shapes are dilations of the original shape, centered at a specific point. The scale factor of the dilation depends on the height of the cross-section or the distance from the point on the base. (4 min)

Slicing a Rectangular Pyramid

Explore what happens when you slice vertically into a rectangular pyramid. (4 min)

Ways to Cross-Section a Cube

Learn about all the different ways we can obtain cross-sections of a cube. (7 min)

Rotating 2D Shapes in 3D

Explore rotating various 2D shapes and see what 3D objects you get. (4 min)

Cavalieri's Principal & Dissection Methods

Cavalieri's Principle in 3D

Cavalieri's principle tells us that if 2 figures have the same height and the same cross-sectional area at every point along that height, they have the same volume. (5 min)

Volume of Pyramids Intuition

Find out what that fraction is by cutting a prism into several pyramids. (8 min)

Volumes of Cones Intuition

Use Cavalieri's principle to establish that the formula for the volume of a cone is the same as the formula for the volume of a pyramid ($\frac{1}{3} \times \text{base area} \times \text{height}$). (6 min)

Using Related Volumes

Use related volumes (using the volume of one figure to determine the volume of another). (6 min)

Volume & Surface Area

Volume of Triangular Prism & Cube

Use the formulas for the volume of triangular prism and cube to solve some solid geometry problems. (4 min)

Volume of a Cone

Learn the formula for the volume of a cone is $V = \frac{1}{3}h\pi r^2$. (6 min)

Cylinder Volume & Surface Area

Learn the cylinder's volume is $\pi r^2 h$, and its surface area is $2\pi r h + 2\pi r^2$. (8 min)

Volume of a Sphere

The formula for the volume of a sphere is $V = \frac{4}{3}\pi r^3$, where V = volume and r = radius. The radius of a sphere is half its diameter. So, to calculate the surface area of a sphere given the diameter of the sphere, you can first calculate the radius, then the volume. (2 min)

Applying Volume of Solids

Calculate the volume of a grain hopper and then use the given rate to solve an applied problem. (7 min)

Area Density

Learn that area or surface density is the amount of a quantity (often mass) per unit of area. $\text{Density} = \text{Quantity} / \text{Area}$. (4 min)

Volume Density

Learn that volume density is the amount of a quantity (often mass) per unit of volume.
 $\text{Density} = \text{Quantity} / \text{Volume}$. (4 min)

Algebra II

Polynomial Arithmetic

| Polynomials Intro

This introduction to polynomials covers common terminology like terms, degree, standard form, monomial, binomial and trinomial. Polynomials are sums of terms of the form $k \cdot x^n$, where k is any number and n is a positive integer. (11 min)

The Parts of Polynomial Expressions

Learn to identify terms, coefficients, and exponents in a polynomial. (3 min)

Finding Average Rate of Change of Polynomials

Learn how to calculate the average rate of change of a function over a specific interval. (4 min)

Sign of Average Rate of Change of Polynomials

Discover how to find the average rate of change in polynomials. (5 min)

Adding Polynomials

Learn how to simplify polynomials by combining like terms (2 min)

Subtracting Polynomials

Learn how to distribute negative signs across terms, combine like terms, and simplify expressions. (2 min)

Polynomial Subtraction

Discover how distributing a negative sign changes the signs of all terms in a polynomial. (3 min)

Multiplying Monomials

Discover how to multiply numbers and variables separately, then combine them for the final answer. (3 min)

Multiplying Monomials by Polynomials: Area Model

By breaking down a rectangle into smaller parts, we can find the total area by multiplying the height and width of each part. This method introduces us to the concept of multiplying monomials by polynomials. (2 min)

Area Model for Multiplying Polynomials with Negative Terms

Discover how to multiply monomials by polynomials using area models. (5 min)

Multiplying Monomials by Polynomials

Discover how to multiply monomials by polynomials using the distributive property. (3 min)

Binomials by Polynomials: Area Model

By breaking down the big rectangle into smaller ones, we can find the area and thus the product of the polynomials. (7 min)

Multiplying Binomials by Polynomials

Learn how to multiply binomials by polynomials by using the distributive property to multiply each term. (3 min)

Polynomial Special Products: Difference of Squares

Dive into the exciting world of special products of polynomials, focusing on the difference of squares. (4 min)

Polynomial Special Products: Perfect Square

Explore how to use the perfect square pattern to square more complex binomials (5 min)

Complex Numbers

Intro to the Imaginary Numbers

Learn about the imaginary unit, "i", a unique number defined as the square root of -1. (5 min)

Simplifying Roots of Negative Numbers

Explore how to simplify the square root of negative numbers using 'i', the principal square root of -1. (4 min)

Powers of the Imaginary Unit

Discover how the powers of 'i' cycle through values, making it possible to calculate high exponents of 'i' easily. (7 min)

i as the Principal Root of -1

Explore the concept of 'i' is equal to the square root of -1, and every complex number can be expressed as $a + bi$, where a and b are real numbers. (7 min)

Intro to Complex Numbers

Explain how we obtain complex numbers by adding real numbers and imaginary numbers. (5 min)

Classifying Complex Numbers

Learn how real and imaginary numbers are subsets of complex numbers and study how to classify numbers as real, pure imaginary, or complex. (5 min)

Plotting Numbers on the Complex Plane

Learn how to plot complex numbers on a unique two-dimensional grid known as the complex plane. (2 min)

Adding Complex Numbers

Learn how to break down the process of adding complex numbers into simple steps. (2 min)

Subtracting Complex Numbers

Learn how to break down the process of subtracting complex numbers into simple steps. (2 min)

Multiplying Complex Numbers

Discover how to multiply complex numbers using the distributive property or FOIL method. (5 min)

Solving Quadratic Equations: Complex Roots

Learn to break down the process of solving quadratic equations using the quadratic formula and standard form. (10 min)

Polynomial Factorization

Introduction to Factoring Higher Degree Polynomials

Learn to simplify third-degree polynomials and tackle fourth-degree monomials. (6 min)

Introduction to Factoring Higher Degree Monomials

Learn to factor monomials like $6x^7$ as $2x^3 \cdot 3x^4$ or as $x^6 \cdot 6x$. (5 min)

Which Monomial Factorization is Correct?

Learn that factoring monomials involves breaking down an expression into two parts. (2 min)

Worked Example: Finding the Missing Monomial Factor

Learn how to use exponent properties to rewrite complex expressions and get a firm grasp on the crucial role that coefficients and exponents play in this process. (3 min)

Worked Example: Finding Missing Monomial Side in Area Model

Find the length of a rectangle whose area is $42xy^3$ and whose height is $14xy$. (2 min)

Greatest Common Factor of Monomials

Explore prime factorization and variable parts and learn how to break down monomials into their simplest forms. (3 min)

Taking Common Factor from Binomial

Explore the process of factoring polynomials using the greatest common monomial factor. (5 min)

Taking Common Factor from Trinomial

Learn how to identify the greatest common factor of a trinomial expression and use it to simplify the expression. (6 min)

Taking Common Factor: Area Model

Learn how to find the greatest common monomial factor of terms and uses the area of a rectangle as a visual aid. (5 min)

Factoring Higher-Degree Polynomials: Common Factor

Discover the art of factoring higher degree polynomials. (4 min)

Identifying Quadratic Patterns

Determine whether the polynomial $9x^8+6x^4y+y^2$ can be factored using the perfect square pattern or the difference of squares pattern (or neither). (6 min)

Factorization with Substitution

Explore how to simplify complex expressions by identifying patterns and substituting variables. (5 min)

Factoring Using the Perfect Square Pattern

Factor $25x^4-30x^2+9$ as $(5x^2-3)^2$. (3 min)

Factoring Using the Difference of Squares Pattern

If we expand $(a+b)(a-b)$ we will get a^2-b^2 . Factorization goes the other way: suppose we have an expression that is the difference of two squares, like x^2-25 or $49x^2-y^2$, then we can factor is using the roots of those squares. (2 min)

Polynomial Identities Introduction

Discover that polynomial identities are equations that are true for all possible values of the variable. (5 min)

Analyzing Polynomial Identities

Explore two cases of polynomial identities and their proofs. (8 min)

Describing Numerical Relationships with Polynomial Identities

Explore how to use identities to prove that the differences between consecutive square numbers (1,4,9,...) are consecutive odd numbers (1,3,5,...). (5 min)

Geometric Series

Geometric Series Introduction

Explore how a geometric series is the sum of the first few terms of a geometric sequence. (6 min)

Finite Geometric Series Formula

Explore the finite geometric series formula is $a(1-r^n)/(1-r)$. (7 min)

Worked Examples: Finite Geometric Series

Evaluate three geometric series (defined in various ways) using the finite geometric series formula $a(1-r^n)/(1-r)$. (7 min)

Geometric Series Word Problems: Swing

Find an expression for the total length and calculate it for a specific number of swings. (6 min)

Geometric Series Word Problems: Hike

Modeling the length of a hike with a geometric series. (7 min)

Polynomial Division

Polynomial Division Introduction

Explore how some quotients end up as a polynomial, while other times we have a remainder and cannot express the quotient as a polynomial. (5 min)

Dividing Polynomials by X (No Remainders)

Finding the quotient $(x^4 - 2x^3 + 5x)/x$ is the same as asking "what should we multiply by x to get $x^4 - 2x^3 + 5x$?". (5 min)

Divide Polynomials by X (With Remainders)

Learn how to divide $(18x^4 - 3x^2 + 6x - 4)$ by $6x$. (5 min)

Intro to Long Division of Polynomials

Any quotient of polynomials $a(x)/b(x)$ can be written as $q(x) + r(x)/b(x)$, where the degree of $r(x)$ is less than the degree of $b(x)$. (12 min)

Dividing Quadratics by Linear Expressions (No Remainders)

Explore how you can divide polynomials similarly to how we divide integers. (4 min)

Dividing Quadratics by Linear Expressions with Remainders

Learn about dividing quadratics by linear expressions with remainders. (5 min)

Dividing Quadratics by Linear Expressions with Remainders: Missing X-Term

An interesting case in polynomial division is when one of the terms is missing. For example $(x^2 + 1)$ divided by $(x + 2)$. Learn how to avoid any mistakes in such cases. (5 min)

Dividing Polynomials by Linear Expressions

Dividing $(3x^3 + 4x^2 - 3x + 7)$ by $(x + 2)$ using long division. (4 min)

Dividing Polynomials by Linear Expressions: Missing Term

Dividing $(2x^3 - 47x - 15)$ by $(x - 5)$ using long division. (5 min)

Factoring Using Polynomial Division

Use the fact that $(x + 2)$ is a factor of $(4x^3 + 19x^2 + 19x - 6)$ to completely factor the polynomial. (6 min)

Factoring Using Polynomial Division: Missing Term

Using the fact that $(x + 6)$ is a factor of $(x^3 + 9x^2 - 108)$ to completely factor the polynomial. (4 min)

Polynomial Remainder Theorem

Intro to the Polynomial Remainder Theorem

The polynomial remainder theorem allows us to determine whether a linear expression is a factor of a polynomial expression easily. (7 min)

Remainder Theorem: Finding Remainder from Equation

Find the remainder of $(-3x^3 - 4x^2 + 10x - 7)$ divided by $(x - 2)$ using the PRT (Polynomial Remainder Theorem). (4 min)

Remainder Theorem Examples

Explore that the polynomial remainder theorem says that for a polynomial $p(x)$ and a number a , the remainder on division by $(x - a)$ is $p(a)$. (6 min)

Remainder Theorem: Checking Factors

Check whether $(x - 3)$ is a factor of $(2x^4 - 11x^3 + 15x^2 + 4x - 12)$ using the factor theorem. (4 min)

Remainder Theorem: Finding Coefficients

Determine the value of coefficient c in $p(x) = x^3 + 2x^2 + cx + 10$, for $(x - 5)$ to be a factor of p . (4 min)

Proof of the Polynomial Remainder Theorem

Learn to use the PRT (Polynomial Remainder Theorem) to prove problems. (6 min)

Polynomial Graphs

Zeros of Polynomials Introduction

Explore that the zeros of a polynomial $p(x)$ are all the x -values that make the polynomial equal to zero. (5 min)

Zeros of Polynomials: Plotting Zeros

When given a polynomial in factored form, find the polynomial's zeros, and represent them as the x -intercepts of the polynomial's graph. (3 min)

Zeros of Polynomials: Matching Equation to Zeros

When given a list of the zeros of a polynomial, we can conclude the polynomial must have certain factors, which gives us information about the equation of the polynomial. (4 min)

Zeros of Polynomials: Matching Equation to Graph

When we are given the graph of a polynomial, we can deduce what its zeros are, which helps us determine a few factors the polynomial's equation must include. (3 min)

Zeros of Polynomials (With Factoring): Grouping

Follow along with this example of a 3rd degree polynomial we can factor using the method of grouping. (5 min)

Zeros of Polynomials (With Factoring): Common Factor

Follow along with this example of a 3rd degree polynomial we can factor by first taking a common factor and then using the sum-product pattern. (4 min)

Positive and Negative Intervals of Polynomials

Given the graph of a polynomial and looking at its x-intercepts, we can determine the factors the polynomial must have. (9 min)

Multiplicity of Zeros of Polynomials

Multiplicity is a fascinating concept, and it is directly related to graphical behavior of the polynomial around the zero. (7 min)

Zeros of Polynomials (Multiplicity)

Given the graph of a polynomial and looking at its x-intercepts, we can determine the factors the polynomial must have. (5 min)

Intro to End Behavior of Polynomials

Explain what "end behavior" is and what affects the end behavior of polynomial functions. (8 min)

Rational Exponents & Radicals

Intro to Rational Exponents

Explore what it means to take a number by a power which is a unit fraction. (5 min)

Rewriting Roots as Rational Exponents

Solve several problems about the equivalence of expressions with roots and rational exponents. (4 min)

Exponential Equation with Rational Answer

Solve for the unknown in $3^a = {}^5\sqrt{3^2}$. (4 min)

Rewriting Quotient of Powers (Rational Exponents)

Rewrite the expression $m^{(7/9)} / m^{(1/3)}$ as a single exponential term $m^{(4/9)}$. (3 min)

Rewriting Mixed Radical and Exponential Expressions

Rewrite $(r^{(2/3)}s^3)^{2*}\sqrt{(20r^4s^5)}$, once as an exponential expression and once as a radical expression. (7 min)

Evaluating Fractional Exponents

Show how to evaluate $64^{(2/3)}$ and $(8/27)^{(-2/3)}$. (6 min)

Evaluating Fractional Exponents: Negative Unit-Fraction

Learn to evaluate powers that are negative unit fractions, like 9 raised to $-1/2$ and 27 raised to $-1/3$. (3 min)

Evaluating Fractional Exponents: Fractional Base

Show how to evaluate $(25/9)^{(1/2)}$ and $(81/256)^{(-1/4)}$. (4 min)

Evaluating quotient of Fractional Exponents

Simplify the complicated expression $256^{(4/7)} / 2^{(4/7)}$ until the expression is equal to 16. (4 min)

Evaluating Mixed Radicals and Exponents

Explore this example of calculating an expression that has both a radical and an exponent. (3 min)

Rewriting Exponential Expressions as A·B^t

Simplify the expression $10*9^{(0.5t+2)}*5^{(3t)}$ as $810*375^t$. (5 min)

Equivalent Forms of Exponential Expressions

Explore how to rewrite $(1/32)*2^t$ as $32*1024^{(t/10-1)}$. (9 min)

Solving Exponential Equations Using Exponent Properties

Solve equations like $26^{(9x+5)} = 1$ and $2^{(3x+5)} = 64^{(x-7)}$. (5 min)

Solving Exponential Equations Using Exponent Properties (Advanced)

Solve equations like $26^{(9x+5)} = 1$ and $2^{(3x+5)} = 64^{(x-7)}$. (7 min)

Exponential Models

Interpreting Change in Exponential Models

Find the factor by which a quantity changes over a single time unit in various exponential models. (7 min)

Interpreting Time in Exponential Models

Find the time interval over which a quantity changes by a given factor in various exponential models. (7 min)

Constructing Exponential Models

Model the distribution of a chain letter using an exponential function. (4 min)

Constructing Exponential Models: Half Life

Model the decay of Carbon-14 samples using an exponential function. (4 min)

Constructing Exponential Models: Percent Change

Model a population of narwhals using an exponential function. (5 min)

Interpreting Change in Exponential Models: With Manipulation

Analyze the rate of change of various exponential models, where the function that models the situation needs some manipulation. (5 min)

Interpreting Change in Exponential Models: Changing Units

Analyze the rate of change of various exponential models for different time units by manipulating the functions that model the situations. (4 min)

Intro to Logarithms

Intro to Logarithms

Explain what logarithms are and gives a few examples of finding logarithms. (7 min)

Evaluating Logarithms (Advanced)

Evaluate $\log_2(8)$, $\log_8(2)$, $\log_2(\frac{1}{8})$, and $\log_8(\frac{1}{2})$. (4 min)

Exponentials & Logarithms: Graphs

Given a few points on the graph of an exponential function, Sal plots the corresponding points on the graph of the corresponding logarithmic function. (4 min)

The Constant E & the Natural Logarithm

***e* and Compound Interest**

Discover a very special number in the world of math: the constant *e*. (12 min)

***e* as a Limit**

Dig deeper into the mathematical definition of *e*. (6 min)

Evaluating Natural Logarithm with Calculator

Evaluate $\log_e(67)$ (which is more commonly written as $\ln(67)$) using a calculator. (4 min)

Properties of Logarithms & Change of Base

Intro to Logarithm Properties (Part 1)

Introduce the logarithm identities for addition and subtraction of logarithms. (9 min)

Intro to Logarithm Properties (Part 2)

Explore the logarithm identities for multiplication of logarithm by a constant, and the change of base rule. (10 min)

Using the Logarithmic Product Rule

Learn to rewrite $\log_3(27x)$ as $\log_3(27) + \log_3(x)$, which is simplified as $3 + \log_3(x)$. (5 min)

Using the Logarithmic Power Rule

Learn to rewrite $\log_5(x^3)$ as $3\log_5(x)$. (5 min)

Using the Properties of Logarithms: Multiple Steps

Learn to rewrite $\log_5([25^x]/y)$ as $2x - \log_5(y)$ by using both the log subtraction property and the log multiplied by a constant property. (2 min)

Proof of the Logarithm Product Rule

Explore how to prove the logarithm addition property, $\log(a) + \log(b) = \log(ab)$. (7 min)

Proof of the Logarithm Quotient and Power Rules

Explore how to prove logarithm addition property, $\log(a) + \log(b) = \log(ab)$. (8 min)

Evaluating Logarithms: Change of Base Rule

Approximate $\log_5(100)$ by rewriting it as $\log(100)/\log(5)$ using the change of base rule, then evaluates with a calculator. (8 min)

Using the Logarithm Change of Base Rule

Explore how to rewrite logarithmic expressions like $1/(\log_a 4)$ or $\log_a(16) \cdot \log_2(a)$ using the change of base rule. (7 min)

Proof of the Logarithm Change of Base Rule

Explore how to prove the logarithmic change of base rule, $\log_a(b) = \log_x(b)/\log_x(a)$. (5 min)

Solving Exponential Equations with Logarithms

Solving Exponential Equations Using Logarithms: Base-10

Solve the equation $10^{(2t-3)} = 7$. (3 min)

Solving Exponential Equations Using Logarithms: Base-2

Learn to use logarithms to solve *any* exponential equation of the form $a \cdot b^{cx} = d$. (5 min)

Exponential Model Word Problem: Medication Dissolve

Solve an exponential equation to answer a question about an exponential model. (4 min)

Exponential Model Word Problem: Bacteria Growth

Evaluate an exponential function at a specific value to answer a question about an exponential model. (2 min)

Transformations of Functions

Shifting Functions Introduction

Explore how the graph of $y=f(x)+k$ (where k is a real number) is the same as the graph of $y=f(x)$ only it's shifted up (when $k>0$) or down (when $k<0$). (6 min)

Shifting Functions Examples

Analyze two cases where functions f and g are given graphically, and g is a result of shifting f . (8 min)

Graphing Shifted Functions

Given the graph of $f(x)=x^2$, graphs $g(x)=(x-2)^2-4$, which is the graph of f shifted 2 units to the right and 4 units down. (3 min)

Reflecting Functions Introduction

Learn to reflect the graph of $y=f(x)$ over the x -axis by graphing $y=-f(x)$ and over the y -axis by graphing $y=f(-x)$. (7 min)

Reflecting Functions: Examples

We can reflect the graph of any function f about the x -axis by graphing $y=-f(x)$ and we can reflect it about the y -axis by graphing $y=f(-x)$. (6 min)

Function Symmetry Introduction

Learn about the two types of symmetry we call even and odd functions. (6 min)

Even and Odd Functions: Graphs

Pick the function that is odd among three functions given by their graphs. (4 min)

Even and Odd Functions: Tables

Even functions are symmetrical about the y -axis: $f(x)=f(-x)$. Odd functions are symmetrical about the x - and y -axis: $f(x)=-f(-x)$. Let's use these definitions to determine if a function given as a table is even, odd, or neither. (4 min)

Even and Odd Functions: Equations

When given the equation of a function $f(x)$, check whether the function is even, odd, or neither by evaluating $f(-x)$. (4 min)

Even and Odd Functions: Find the Mistake

See another student's work when trying to determine whether a function is even, odd, or either, and decide whether they made a mistake, and if so, where. (4 min)

Scaling Functions Introduction

Explore how operations are classified as scaling. (6 min)

Scaling Functions Vertically: Examples

See multiple examples of how we relate the two functions and their graphs, and determine the value of k . (5 min)

Scaling Functions Horizontally: Examples

Explore the function $f(k \cdot x)$ is a horizontal scaling of f . (8 min)

Identifying Horizontal Squash from Graph

Given the graphs of functions f and g , where g is the result of compressing f by a factor of 2, find $g(x)$ in terms of $f(x)$. (4 min)

Identifying Function Transformations

Explore several examples of how to write $g(x)$ implicitly in terms of $f(x)$ when $g(x)$ is a shift or a reflection of $f(x)$. (7 min)

Graphing Radical, Exponential, & Logarithmic Functions

Graphing Square and Cube Root Functions

Graph various square root and cube root functions by thinking of them as transformations of the parent graphs $y=\sqrt{x}$ and $y=\sqrt[3]{x}$. (7 min)

Transforming Exponential Graphs (Example 1)

Given the graph of $y=2^x$, graph $y=2^{-x}-5$, which is a horizontal reflection and shift of $y=2^x$. (3 min)

Transforming Exponential Graphs (Example 2)

Given the graph of $y=2^x$, graph $y=(-1)2^{x+3}+4$, which is a vertical reflection and a shift of $y=2^x$. (5 min)

Graphing Exponential Functions

Graph $y=-2 \cdot 3^x+5$ using our interactive graphing widget. (4 min)

Graphical Relationship Between 2^x and $\log_2(x)$

Graph $y=2^x$ and $y=\log_2(x)$ on the same coordinate plane, showing how they relate as graphs of inverse functions. (6 min)

Graphing Logarithmic Functions (Example 1)

Graph $y=2\log_2(-x-3)$ by viewing it as a transformation of $y=\log_2(x)$. (6 min)

Graphing Logarithmic Functions (Example 2)

Graph $y=4\log_2(x+6)-7$ by viewing it as a transformation of $y=\log_2(x)$. (5 min)

More Types of Equations & Solutions

Rational Equations Intro

Learn about a rational equation which is when an equation where the variable is in the denominator of a quotient. (3 min)

Equations with Rational Expressions (Example 1)

Solve $(x^2-10x+21)/(3x-12)=(x-5)/(x-4)$, which has one real solution and one extraneous solution. (5 min)

Equations with Rational Expressions (Example 2)

Solve $(-2x+4)/(x-1)=3/(x+1)-1$. (7 min)

Finding Inverses of Rational Functions

Find an expression for the inverse of f by solving the equation $x=f(y)$ for the variable y . (4 min)

Intro to Square-Root Equations & Extraneous Solutions

Explore what square-root equations are and show an example of solving such an equation while checking for extraneous solutions. (11 min)

Square-Root Equations Intro

Explore an example of how an extraneous solution arises when solving $2x-1=\sqrt{8-x}$. (5 min)

Solving Square-Root Equations: One Solution

Solve the equation $3+\sqrt{5x+6}=12$. (3 min)

Solving Square-Root Equations: Two Solutions

Solve the equation $6+3w=\sqrt{2w+12}+2w$ which has two solutions. (5 min)

Solving Square-Root Equations: No Solution

Solve the equation $\sqrt{3x-7}+\sqrt{2x-1}=0$, only to find out that the single solution is extraneous, which means the equation has no solution. (4 min)

Extraneous Solutions

Explore how and why we get extraneous solutions, by understanding the logic behind the process of solving equations. (8 min)

Equation that has a Specific Extraneous Solution

Find the value of d for which $\sqrt{3x+25}=d+2x$ has an extraneous solution at $x=-3$. (5 min)

Solving Cube-Root Equations

Solve the equation $\sqrt[3]{y}=4\sqrt[3]{y+5}$. (4 min)

Quadratic Systems: A Line and a Parabola

Explore how a system of equations that contains one linear equation, and one quadratic equation can be solved both graphically and algebraically. (6 min)

Quadratic Systems: A Line and a Circle

Solve the system $y=x+1$ and $x^2+y^2=25$. (4 min)

Quadratic System with No Solutions

Solve a system of two quadratic equations algebraically and finds the system has no solutions. (7 min)

Solving Equations by Graphing

Explore how to solve a system of equations by graphing the equations and looking for intersection points. (4 min)

Solving Equations by Graphing: Intro

Learn that you can always solve an equation by graphing it, although the solution might not be exact. (5 min)

Solving Equations by Graphing: Graphing Calculator

Learn to approximate the solutions to any equation by graphing both sides of the equation and looking for intersection points. (4 min)

Solving Equations by Graphing: Word Problems

Learn to approximate the solutions of any equation by graphing both sides of the equation and looking for the intersection point. (9 min)

The Unit Circle, Radians, & Trig Identities

Unit Circle

Learn how to use the unit circle to define sine, cosine, and tangent for all real numbers. (9 min)

The Trig Functions & Right Triangle Trig Ratios

Learn how, for acute angles, the two different definitions of the trigonometric values (SOH CAH TOA and the unit circle definition) result in the same values. (7 min)

Intro to Radians

Explain the definition and motivation for radians and the relationship between radians and degrees. (11 min)

Radians & Degrees

Discuss the general approach to converting between radians and degrees and vice versa. (7 min)

Degrees to Radians

Learn to convert from degrees to radians, multiply the number of degrees by $\pi/180$. (7 min)

Radians to Degrees

Learn to change from radians to degrees, you need to multiply the number of radians by $180/\pi$. (3 min)

Radian Angles & Quadrants

Determine the quadrant at which a ray falls after a rotation by a certain measure of radians. (4 min)

Trig Values of $\pi/4$

Find the trigonometric values of $\pi/4$ using the unit-circle definition. (8 min)

Proof of the Pythagorean Trig Identity

Prove this identity using the Pythagorean theorem in the unit circle with $x^2+y^2=1$. (6 min)

Using the Pythagorean Trig Identity

Explore the Pythagorean identity tells us that no matter what the value of θ is, $\sin^2\theta + \cos^2\theta$ is equal to 1. (6 min)

Features & Graphs of Trigonometric Functions

Graph of $y=\sin(x)$

Explore how the graph of $y=\sin(x)$ is like a wave that forever oscillates between -1 and 1, in a shape that repeats itself every 2π units. (9 min)

Intersection Points of $y=\sin(x)$ and $y=\cos(x)$

Draw the graphs of the sine and the cosine functions and analyze their intersection points. (12 min)

Graph of $y=\tan(x)$

Draw the graph of the tangent function based on the unit circle definition of the function. (10 min)

Features of Sinusoidal Functions

Explore the main features of sinusoidal functions: midline, amplitude, & period. (5 min)

Amplitude & Period of Sinusoidal Functions from Equation

Find the amplitude and the period of $y=-0.5\cos(3x)$. (8 min)

Transforming Sinusoidal Graphs: Vertical Stretch & Horizontal Reflection

Graph $y=2\sin(-x)$ by considering it as a vertical stretch and a horizontal reflection of $y=\sin(x)$. (13 min)

Transforming Sinusoidal Graphs: Vertical & Horizontal Stretches

Graph $y=-2.5\cos(1/3x)$ by considering it as a vertical stretch and reflection, and a horizontal stretch, of $y=\cos(x)$. (11 min)

Example: Graphing $y=3\sin(1/2x)-2$

Graph $y=3\sin(1/2x)-2$ by thinking about the graph of $y=\sin(x)$ and analyzing how the graph (including the midline, amplitude, and period) changes as we perform function transformations to get from $y=\sin(x)$ to $y=3\sin(1/2x)-2$. (4 min)

Example: Graphing $y=-\cos(\pi x)+1.5$

Graph $y=-\cos(\pi x)+1.5$ by thinking about the graph of $y=\cos(x)$ and analyzing how the graph (including the midline, amplitude, and period) changes as we perform function transformations to get from $y=\cos(x)$ to $y=-\cos(\pi x)+1.5$. (3 min)

Sinusoidal Function from Graph

Find the equation of a sinusoidal function from its graph where the minimum point (-2,-5) and the maximum point (2,1) are highlighted. (5 min)

Interpreting Trigonometric Graphs in Context

When a trigonometric function models a real-world relationship, we can assign meaning to its midline, amplitude and period. (6 min)

Trig Word Problem: Modeling Daily Temperature

Solve a word problem about the daily change in temperature by modeling it with a sinusoidal function. (11 min)

Trig Word Problem: Modeling Annual Temperature

Solve a word problem about the annual change in temperature by modeling it with a sinusoidal function. (7 min)

Trig Word Problem: Length of Day (Phase Shift)

Solve a word problem about the annual change in the length of day by modeling it with a sinusoidal function that has a phase shift. (8 min)

Modeling & Analysis Using Functions

Modeling with Function Combination

Model the height of a tree on top of a tower, by adding the functions that model the growth of the tree and the tower separately. (3 min)

Periodicity of Algebraic Models

Analyze the periodicity of graphs that model real world situations. (3 min)

End Behavior of Algebraic Models

Analyze the end behavior of graphs that model real world situations. (3 min)

Symmetry of Algebraic Models

Interpret the significance of modeling function being even. (3 min)

Manipulating Formulas: Perimeter

Rewrite the formula for the perimeter of a rectangle so it is solved for width. (7 min)

Manipulating Formulas: Area

Rewrite the formula for the area of a triangle so it is solved for height. (3 min)

Manipulating Formulas: Temperature

Take the formula for converting from Fahrenheit temperature to Celsius and solve it for F so it serves to convert from Celsius to Fahrenheit. (3 min)

Graph Labels and Scales

When graphing a real-world relationship, we need to pick labels and axis scales that are appropriate for the purpose of our model. (4 min)

Rational Equation Word Problem

Model a context that concerns the number and price of pizza slices. (9 min)

Quadratic Inequality Word Problem

Model a context that concerns a candy vending machine. (10 min)

Exponential Equation Word Problem

Model a context that concerns a bank savings account. (9 min)

Modeling with Multiple Variables:

Pancakes

Explore this example of a model that relates different quantities in the context of making pancakes. (3 min)

Modeling with Multiple Variables:

Roller Coaster

Explore this example of a model that relates different quantities in the context of roller coaster rides. (3 min)

Modeling with Multiple Variables:

Taco Stand

Explore this example of a model that relates different quantities related to the daily profits of a taco stand. (3 min)

Modeling with Multiple Variables:

Ice Cream

Explore this example of a model that relates different quantities related to two people walking to the same ice cream shop (3 min)

Interpreting Expressions with Multiple Variables: Resistors

Given the expression for the total resistance in an electric circuit with two resistors, analyze the expression to tell what happens to the total resistance when the resistance of one resistor increases and the resistance of the other resistor stays the same. (3 min)

Interpreting Expressions with Multiple Variables: Cylinder

Given the value and the expression for the radius of a cylinder, find the radius of a cylinder with the same volume and 100 times the height. (4 min)

Trigonometry

Right Triangles & Trigonometry

Using Similarity to Estimate Ratio Between Side Lengths

When two right triangles share an acute angle measure, the ratios of the corresponding side lengths within the triangles are equal. (4 min)

Using Right Triangle Ratios to Approximate Angle Measure

Explore how all right triangles with a given acute angle measure have equal ratios between their side lengths. (3 min)

Triangle Similarity & the Trigonometric Ratios

Explain how the trigonometric ratios are derived from triangle similarity considerations. (9 min)

Trigonometric Ratios in Right Triangles

Explore a few examples where that start with the two legs of a right triangle, and then find the trig ratios of one of the acute angles. (12 min)

Solving for a Side in Right Triangles with Trigonometry

Given a right triangle with an acute angle of 65° and a leg of 5 units, use trigonometry to find the two missing sides. (7 min)

Intro to the Pythagorean Trig Identity

Explore the identity $(\sin\theta)^2 + (\cos\theta)^2 = 1$, which arises from the Pythagorean theorem. (4 min)

Sine & Cosine of Complementary Angles

Explore that the sine of any angle is equal to the cosine of its complementary angle. (4 min)

Using Complementary Angles

Solve the following problem: Given that $\cos(58^\circ) = 0.53$, find $\sin(32^\circ)$. (4 min)

Trig Word Problem: Complementary Angles

Solve a problem about a submerged pyramid using the fact that the sine of an angle is equal to the cosine of its complementary angle. (5 min)

Challenge Problem: Trig Values & Side Ratios

Given a diagram with multiple right triangles and is asked to match different expressions with different trig values. (10 min)

Right Triangle Word Problem

Solve a modeling problem where he finds the necessary angle to shoot at a vicious alien. (4 min)

Finding Reciprocal Trig Ratios

Find all six trigonometric ratios (sine, cosine, tangent, secant, cosecant, and cotangent) of an angle in each right triangle. (5 min)

Using Reciprocal Trig Ratios

Given two sides in a right triangle and the cotangent of one of the angles and use this information to find the missing side. (6 min)

The Unit Circle, Radians, & Trig Identities

Unit Circle

Learn how to use the unit circle to define sine, cosine, and tangent for all real numbers. (9 min)

The Trig Functions & Right Triangle Trig Ratios

Show how, for acute angles, the two different definitions of the trigonometric values (SOH, CAH, TOA, and the unit circle definition) result in the same values. (7 min)

Intro to Radians

Explain the definition and motivation for radians and the relationship between radians and degrees. (11 min)

Radians & Degrees

Discuss the general approach to converting between radians and degrees and vice versa. (7 min)

Degrees to Radians

Learn to convert from degrees to radians, multiply the number of degrees by $\pi/180$. (7 min)

Radians to Degrees

Learn to change from radians to degrees, you need to multiply the number of radians by $180/\pi$. (3 min)

Radian Angles & Quadrants

Determine the quadrant at which a ray falls after a rotation by a certain measure of radians. (4 min)

Trig Values of $\pi/4$

Find the trigonometric values of $\pi/4$ using the unit-circle definition. (8 min)

Proof of the Pythagorean Trig Identity

Prove this identity using the Pythagorean theorem in the unit circle with $x^2 + y^2 = 1$. (6 min)

Using the Pythagorean Trig Identity

Explore the Pythagorean identity tells us that no matter what the value of θ is, $\sin^2\theta + \cos^2\theta$ is equal to 1. (6 min)

Cosine, Sine and Tangent of $\pi/6$ and $\pi/3$

With the unit circle and the Pythagorean theorem, we can find the exact sine, cosine, and tangent of the angles $\pi/6$ and $\pi/3$. (9 min)

Sine & Cosine Identities: Symmetry

Find several trigonometric identities for sine and cosine by considering horizontal and vertical symmetries of the unit circle. (8 min)

Tangent Identities: Symmetry

Find several trigonometric identities for tangent by considering horizontal and vertical symmetries of the unit circle. (7 min)

Sine & Cosine Identities: Periodicity

Find trigonometric identities for sine and cosine by considering angle rotations on the unit circle. (6 min)

Tangent Identities: Periodicity

Solve a problem by considering the periodicity of the tangent function. (4 min)

Features & Graphs of Trigonometric Functions

Graph of $y = \sin(x)$

Find the graph of $y = \sin(x)$ using the unit-circle definition of $\sin(x)$. (9 min)

Intersection Points of $y = \sin(x)$ and $y = \cos(x)$

Draw the graphs of the sine and the cosine functions and analyze their intersection points. (11 min)

Graph of $y = \tan(x)$

Draw the graph of the tangent function based on the unit circle definition of the function. (10 min)

Features of Sinusoidal Functions

Explore the main features of sinusoidal functions: midline, amplitude, & period. (5 min)

Amplitude & Period of Sinusoidal Functions from Equation

Find the amplitude and the period of $y = -0.5\cos(3x)$. (8 min)

Transforming Sinusoidal Graphs:

Vertical Stretch & Horizontal Reflection

Graph $y = 2\sin(-x)$ by considering it as a vertical stretch and a horizontal reflection of $y = \sin(x)$. (13 min)

Transforming Sinusoidal Graphs:

Vertical & Horizontal Stretches

Graph $y = -2.5\cos(1/3x)$ by considering it as a vertical stretch and reflection, and a horizontal stretch, of $y = \cos(x)$. (11 min)

Example: Graphing $y = 3\sin(1/2x) - 2$

Graph $y = 3\sin(1/2x) - 2$ by thinking about the graph of $y = \sin(x)$ and analyzing how the graph (including the midline, amplitude, and period) changes as we perform function transformations to get from $y = \sin(x)$ to $y = 3\sin(1/2x) - 2$. (4 min)

Example: Graphing $y = -\cos(\pi \cdot x) + 1.5$

Graph $y = -\cos(\pi \cdot x) + 1.5$ by thinking about the graph of $y = \cos(x)$ and analyzing how the graph (including the midline, amplitude, and period) changes as we perform function transformations to get from $y = \cos(x)$ to $y = -\cos(\pi \cdot x) + 1.5$. (3 min)

Sinusoidal Function from Graph

Find the equation of a sinusoidal function from its graph where the minimum point $(-2, -5)$ and the maximum point $(2, 1)$ are highlighted. (5 min)

Interpreting Trigonometric Graphs in Context

When a trigonometric function models a real-world relationship, we can assign meaning to its midline, amplitude and period. (5 min)

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Trig Word Problem: Modeling Annual Temperature

Solve a word problem about the annual change in temperature by modeling it with a sinusoidal function. (7 min)

Trig Word Problem: Length of Day (Phase Shift)

Solve a word problem about the annual change in the length of day by modeling it with a sinusoidal function that has a phase shift. (8 min)

Law of Sines & Law of Cosines**Solving for a Side with the Law of Sines**

Given a triangle with two angle measures and one side length, find all the missing side lengths and angle measures using the law of sines. (6 min)

Solving for an Angle with the Law of Sines

Given a triangle with two side lengths and one angle measure, find all the missing angle measures using the law of sines. (5 min)

Proof of the Law of Sines

Give a simple proof of the law of sines. (6 min)

Solving for a Side with the Law of Cosines

Learn how to use the law of cosines to find the missing side length of a triangle when given two side lengths and the contained angle measure. (5 min)

Solving for an Angle with the Law of Cosines

Given a triangle with all side lengths but no angle measure, find one of the angle measures using the law of cosines. (7 min)

Proof of the Law of Cosines

Explore a simple proof of the law of cosines. (9 min)

Trig Word Problem: Stars

Solve a word problem about the distance between stars using the law of cosines. (6 min)

Inverse Trigonometric Functions**Intro to Arcsine**

Explore arcsine, which is the inverse function of sine, and discusses its principal range. (11 min)

Intro to Arctangent

Explore arctangent, which is the inverse function of tangent, and discuss its principal range. (10 min)

Intro to Arccosine

Explore arccosine, which is the inverse function of cosine, and discusses its principal range. (14 min)

Restricting Domains of Functions to Make them Invertible

Given the graph of a trigonometric function and discuss ways in which he can change the function to make it invertible. (6 min)

Domain & Range of Inverse Tangent Function

Find the formula for the inverse function of $g(x) = \tan(x - 3\pi/2) + 6$, and then determine the domain of that inverse function. (10 min)

Using Inverse Trig Functions with a Calculator

Discuss the appropriate way to use the calculator to find an angle when its tangent value is given. (4 min)

Sinusoidal Equations**Solving Sinusoidal Equations of the Form $\sin(x) = d$**

Find the expressions that together represent all possible solutions to the equation $\sin(x) = 1/3$. (6 min)

Cosine Equation Algebraic Solution Set

Solve a cosine equation with an infinite number of solutions. (6 min)

Cosine Equation Solution Set in an Interval

Given the algebraic solution set for a cosine equation, find which solutions fall within an interval. (6 min)

Sine Equation Algebraic Solution Set

Solve a sine equation with an infinite number of solutions. Use trig identities to represent the whole solution set. (5 min)

Solving $\cos(\theta)=1$ and $\cos(\theta)=-1$

Solve the equations $\cos(\theta)=1$ and $\cos(\theta)=-1$ using the graph of $y=\cos(\theta)$. (5 min)

Sinusoidal Models**Interpreting Solutions of Trigonometric Equations**

Starting from a context represented by a trigonometric function, interpret equations based on the function. (4 min)

Trig Word Problem: Modeling Daily Temperature

Solve a word problem about the annual change in temperature by solving a sinusoidal equation. (11 min)

Trig Word Problem: Modeling Annual Temperature

Solve a word problem about the annual change in temperature by solving a sinusoidal equation. (7 min)

Trig Word Problem: Solving for Temperature

Solve a word problem about the annual change in temperature by solving a sinusoidal equation. (8 min)

Trig Word Problem: Length of Day (Phase Shift)

Solve a word problem about the annual change in the length of day by modeling it with a sinusoidal function that has a phase shift. (8 min)

Angle Addition Identities**Trig Angle Addition Identities**

Review 6 related trigonometric angle addition identities: $\sin(a+b)$, $\sin(a-b)$, $\cos(a+b)$, $\cos(a-b)$, $\cos(2a)$, and $\sin(2a)$. (11 min)

Using the Cosine Angle Addition Identity

Evaluate the cosine of the sum of 60° and another angle whose right triangle is given. (5 min)

Using the Cosine Double-Angle Identity

The cosine double angle formula tells us that $\cos(2\theta)$ is always equal to $\cos^2\theta - \sin^2\theta$. (4 min)

Proof of the Sine Angle Addition Identity

Prove the identity $\sin(x+y) = \sin(x)\cos(y) + \cos(x)\sin(y)$. (8 min)

Proof of the Cosine Angle Addition Identity

Prove the identity $\cos(x+y) = \cos(x)\cos(y) - \sin(x)\sin(y)$. (6 min)

Proof of the Tangent Angle Sum and Difference Identities

Using the sine and cosine of the sum or difference of two angles, we can prove: $\tan(x+y) = (\tan(x) + \tan(y)) / (1 - \tan(x)\tan(y))$. (7 min)

Using Trigonometric Identities**Finding Trig Values Using Angle Addition Identities**

Find the value of $\sin(7\pi/12)$ by rewriting it as $\sin(\pi/3 + \pi/4)$ and then using the sine angle addition formula. (9 min)

Using the Tangent Angle Addition Identity

Find the tangent of $13\pi/12$ without a calculator using the tangent angle addition identity. (7 min)

Using Trig Angle Addition Identities: Finding Side Lengths

Given a drawing with two triangles and some side lengths, use the sine angle addition identity in order to find a missing side length. (5 min)

Using Trig Angle Addition Identities: Manipulating Expressions

Given that $\cos(2\theta) = C$, use the cosine double-angle identity to find an expression for $\sin(\theta)$. (6 min)

Using Trigonometric Identities

Trigonometric identities like $\sin^2\theta + \cos^2\theta = 1$ can be used to rewrite expressions in a different, more convenient way. (3 min)

Challenging Trigonometry Problems**Trig Challenge Problem: Area of a Triangle**

Solve a very complicated geometrical trig problem that appeared as problem 11 in the 2003 AIME II exam. (16 min)

Trig Challenge Problem: Area of a Hexagon

Solve a very complicated geometrical trig problem that appeared as problem 14 in the 2003 AIME II exam. (18 min)

Trig Challenge Problem: Cosine of Angle-Sum

Given $\cos(\theta)$ and $\cos(\phi)$ and find $\cos(\theta+\phi)$. (7 min)

Trig Challenge Problem: Arithmetic Progression

Solve a very complicated algebraic trig problem that appeared as problem 29 in the 2010 IIT JEE Paper I exam. (15 min)

Trig Challenge Problem: Maximum Value

Solve a very complicated algebraic trig problem that appeared as problem 48 in the 2010 IIT JEE Paper I exam. (10 min)

Trig Challenge Problem: Multiple Constraints

Solve a very complicated algebraic trig problem that appeared as problem 47 in the 2010 IIT JEE Paper I exam. (13 min)

Trig Challenge Problem: System of Equations

Solve a very complicated algebraic trig problem that appeared as problem 55 in the 2010 IIT JEE Paper I exam. (11 min)

Statistics & Probability

Mean, Median, & Mode

Statistics Intro: Mean, Median, & Mode

The mean (average) of a data set is found by adding all numbers in the data set and then dividing by the number of values in the set. The median is the middle value when a data set is ordered from least to greatest. The mode is the number that occurs most often in a data set. (9 min)

Mean, Median, & Mode Example

Find the mean, median, and mode in this example. (4 min)

Comparing Means of Distributions

Compare the means of two different distributions given as dot plots. (8 min)

Means and Medians of Different Distributions

Compare the mean and median based on a few different distributions. (7 min)

Impact on Median & Mean: Removing an Outlier Explore the mean and median based on a few different distributions. (6 min)

Impact on Median & Mean: Increasing an Outlier Explore the effects of modifying a value in a data set. (4 min)

Missing Value Given the Mean

Learn how to find the value of a missing piece of data if you know the mean of the data set. (5 min)

Median & Range Puzzlers

Solve an interesting median and range challenge problem. (7 min)

Variance & Standard Deviation of Populations & Samples

Measures of Spread: Range, Variance & Standard Deviation

Range, variance, and standard deviation all measure the spread or variability of a data set in different ways. The range is easy to calculate—it's the difference between the largest and smallest data points in a set. Standard deviation is the square root of the variance. Standard deviation is a measure of how spread out the data is from its mean. (13 min)

Variance of a Population

Population variance is a measure of how spread out a group of data points is. (8 min)

Population Standard Deviation

Explore that the population standard deviation is a measure of how much variation there is among individual data points in a population. (8 min)

Mean and Standard Deviation Versus Median and IQR

Learn to choose the "preferred" measures of center and spread when outliers are present in a set of data. (8 min)

Statistics: Alternate Variance Formulas

Explore how this variance is calculated as $\sigma^2 = (\sum (x-\mu)^2) / N$. Another equivalent formula is $\sigma^2 = (\sum x^2) / N - \mu^2$. (12 min)

Sample Variance

Estimate the variance of a population by looking at the data in a sample. (11 min)

Sample Standard Deviation and Bias

Explore an example of calculating standard deviation and bias. (9 min)

Why We Divide by $n - 1$ in Variance

Explore this visualization providing evidence that dividing by $n-1$ truly gives an unbiased estimate of population variance. (5 min)

Simulation Showing Bias in Sample Variance

Discover a better understanding of why we divide by $(n-1)$ when calculating the unbiased sample variance. (6 min)

Simulation Providing Evidence that $(n-1)$ Gives Us Unbiased Estimate

Explore that dividing by $(n-1)$ gives us an unbiased estimate of population variance. (5 min)

Review and Intuition: Why We Divide by $n-1$ for the Unbiased Sample Variance

Review the population mean, sample mean, population variance, sample variance and building an intuition for why we divide by $n-1$ for the unbiased sample variance. (10 min)

Box & Whisker Plots

Worked Example: Creating a Box Plot (Odd Number of Data Points)

Learn how to create a box plot. (3 min)

Worked Example: Creating a Box Plot (Even Number of Data Points)

Learn how to create a box plot. (3 min)

Constructing a Box Plot

Explore this word problem that's perfectly suited for a box and whiskers plot to help analyze data. (8 min)

Reading Box Plots

Discover how box and whisker plots seek to explain data by showing a spread of all the data points in a sample. (3 min)

Interpreting Box Plots

Learn how to evaluate what we know and what we don't know about a dataset given its box plot. (8 min)

Judging Outliers in a Dataset

Using the inter-quartile range (IQR) to judge outliers in a dataset. (8 min)

Other Measures of Spread

Interquartile Range (IQR)

Discover that the IQR describes the middle 50% of values when ordered from lowest to highest. (6 min)

Range and Mid-Range

Discover how the midrange is the average of the largest and smallest data points. (2 min)

Mean Absolute Deviation (MAD)

Discover mean absolute deviation (MAD) of a data set is the average distance between each data value and the mean. (9 min)

Mean Absolute Deviation Example

Find the mean absolute deviation of a data set that's given in a bar chart. (6 min)

Modeling Data Distributions

Calculating Percentile

Learn how to calculate the percentile rank for a given data point. (4 min)

Analyzing a Cumulative Relative Frequency Graph

Learn how to calculate the percentile rank for a given data point. (6 min)

Normal Distribution Problem: Z-Scores

Explore Z-score practice. (8 min)

Comparing with Z-Scores

Use standardized scores—also called z-scores—to compare data points from different distributions. (4 min)

How Parameters Change as Data is Shifted and Scaled

See how transforming a data set by adding, subtracting, multiplying, or dividing a constant affects measures of center and spread. (7 min)

Density Curves

Explore this introduction to density curves for visualizing distributions. (10 min)

Median, Mean and Skew from Density Curves

Analyze how median, mean, left skew, and right skew effects density curves. (6 min)

Density Curve Worked Example

Analyze skew, median, mean and height of a density curve. (4 min)

Worked Example Finding Area Under Density Curves

Explore this example finding area under density curves. (5 min)

Qualitative Sense of Normal Distributions

Explore how "normal" a distribution might be. (11 min)

Normal Distribution Problems:

Empirical Rule

Explore the empirical rule (also called the "68-95-99.7 rule") is a guideline for how data is distributed in a normal distribution. (11 min)

Standard Normal Distribution and the Empirical Rule

Use the empirical rule with a standard normal distribution. (8 min)

More Empirical Rule and Z-Score Practice

Explore the empirical rule and z-score practice. (6 min)

Standard Normal Table for Proportion Below

Finding the proportion of a normal distribution that is below a value by calculating a z-score and using a z-table. (4 min)

Standard Normal Table for Proportion Above

Finding the proportion of a normal distribution that is above a value by calculating a z-score and using a z-table. (5 min)

Standard Normal Table for Proportion Between Values

Finding the proportion of a normal distribution that is between two values by calculating z-scores and using a z-table. (7 min)

Finding Z-Score for a Percentile

Given a particular normal distribution with some mean and standard deviation, use that z-score to find the actual cutoff for that percentile. (4 min)

Threshold for Low Percentile

Find the cutoff for a given lower percentile in a normal distribution. (6 min)

Deep Definition of the Normal Distribution

Explore how normal distribution to explore the parent function that generates normal distributions, and how to modify parameters in the function to produce a normal distribution with any given mean and standard deviation. (26 min)

Normal Distribution Excel Exercise

Show that the normal distribution approximates the binomial distribution for many. (26 min)

Study Design

Statistical Questions

Explore what makes a question a "statistical question." (9 min)

Statistical and Non-Statistical Questions

Learn that a statistical question is one that can be answered by collecting data and where there will be variability in that data. (8 min)

Reasonable Samples

To make a valid conclusion, you'll need a representative, not skewed, sample. (4 min)

Identifying a Sample and Population

Learn to identify a sample and population. (2 min)

Examples of Bias in Surveys

Explore examples of bias in surveys. (6 min)

Example of Under Coverage Introducing Bias

Given the description of a study, we can think about potential sources of bias, and how they may have impacted the results of the study. (4 min)

Correlation and Causality

Understand why correlation does not imply causality (even though many in the press and some researchers often imply otherwise). (11 min)

Picking Fairly

Determine if a few different methods of a magician choosing a volunteer are fair. (7 min)

Techniques for Generating a Simple

Random Sample

Explore techniques for generating a simple random sample. (6 min)

Techniques for Random Sampling and Avoiding Bias

Explore techniques for random sampling and avoiding bias. (9 min)

Types of Statistical Studies

Explore these different types of statistical studies. (11 min)

Worked Example Identifying Experiment

Explore this example identifying experiment. (5 min)

Worked Example Identifying

Observational Study

Explore this example identifying observational study. (7 min)

Worked Example Identifying Sample Study

Explore this example identifying sample study. (3 min)

Appropriate Statistical Study Example

Determine if a statistical study was a sample study, an experiment, or an observational study. (6 min)

Introduction to Experiment Design

Explore experiment design, explanatory and response variables, control and treatment groups. (11 min)

Matched Pairs Experiment Design

Explore matched pairs experiment design. (6 min)

Basic Theoretical Probability

Intro to Theoretical Probability

Explore probability through the example of flipping a quarter and rolling a die. (8 min)

Simple Probability: Yellow Marble

Determine the number of possible outcomes, and then how many of them meet our constraints. (3 min)

Simple Probability: Non-Blue Marble

Figure out the probability of randomly picking a non-blue marble from a bag. (10 min)

Intuitive Sense of Probabilities Explore what probabilities really mean. (9 min)

The Monty Hall Problem

Analyze the famous thought experiment: the "Monty Hall" problem. (8 min)

Probability of Using Sample Spaces

Probability with Counting Outcomes

Explore the probability of getting exactly 2 heads when flipping three coins. (2 min)

Example: All the Ways You Can Flip a Coin

Explore manually going through the combinatorics to determine the probability of an event occurring. (2 min)

Die Rolling Probability

Explore the probability of rolling doubles on a pair of dice and grid out the possible outcomes. (5 min)

Subsets of Sample Spaces

Solve an example about subsets. (6 min)

Basic Set Operations

Intersection and Union of Sets

Learn to find the intersection and union of sets. (8 min)

Relative Complement or Difference Between Sets

Show an example finding the relative complement or difference of two sets A and B. (6 min)

Universal Set and Absolute Complement

Explore the universal set and absolute complement. (6 min)

Subset, Strict Subset, and Superset

A subset of a set A is any set B such that every element of B is also an element of A. A strict subset is a subset that isn't equal to the original set (i.e. B must have at least one fewer element than A). A superset of A is any set C such that A is a subset of C. (4 min)

Bringing the Set Operations Together

Summarize the set operations that he has discussed in the previous videos. (7 min)

Probability, Randomness, & Simulation

Experimental Probability

Explore reasonable estimates of the likelihood of future events. (7 min)

Theoretical and Experimental Probabilities

Compare expected probabilities to what really happens when we run experiments. (7 min)

Making Predictions with Probability

Predict the number of times a spinner will land on an elephant. (5 min)

Experimental Versus Theoretical Probability Simulation

Explore experimental versus theoretical probability simulation. (5 min)

Random Number List to Run Experiment

Use a list of random numbers to simulate multiple trials of an experiment. (8 min)

Random Numbers for Experimental Probability

Use a list of random number to calculate an experimental probability. (8 min)

Statistical Significance of Experiment

Determine if the results of an experiment about advertising are statistically significant. (8 min)

Addition Rule for Probability

Probability with Venn Diagrams

Use a Venn diagram to illustrate the concept of overlapping events and how to calculate the combined probability. (10 min)

Addition Rule for Probability

Explore Venn diagrams and the addition rule for probability. (11 min)

Addition and Multiplication Rule for Probability

Explore the notion of a "sample space". See a sample space represented as a tree diagram, table, and list. (10 min)

Multiplication Rule for Independent Events

Sample Spaces for Compound Events

Learn how to calculate probabilities of coin flips using two methods: listing all possible outcomes or multiplying independent events. (9 min)

Compound Probability of Independent Events

Learn how to calculate probabilities of coin flips using two methods: listing all possible outcomes or multiplying independent events. (6 min)

Probability of a Compound Event

Learn how to use sample space diagrams to find probabilities. (5 min)

"At Least One" Probability with Coin Flipping

Explore the probability of getting at least one head in multiple flips of a fair coin. (9 min)

Free-Throw Probability

Determine the probability of making 10 free throws in a row. (7 min)

Three-Pointer vs. Free-Throw Probability

Determine if there's a high probability of making three free throws in a row or one three-pointer. (6 min)

Probability without Equally Likely Events

Explore probabilities surrounding only equally likely events. (9 min)

Independent Events Example: Test Taking

Consider the probability of two independent events occurring. (5 min)

Die Rolling Probability with Independent Events

Figure out the probability in this problem. (3 min)

Multiplication Rule for Dependent Events

Dependent Probability Introduction

Explore dependent probability using a scenario involving a casino game. (7 min)

Dependent Probability: Coins

How the probability of an event can be dependent on another event occurring in this example problem. (9 min)

Dependent Probability Example

Practice these probability problems as they get more complex eventually. (7 min)

Independent & Dependent Probability

Identify whether the problem is independent or dependent. (3 min)

Dependent Probability

Find dependent probabilities like $P(A | B)$ using an example rolling dice. (10 min)

Conditional Probability & Independence

Calculating Conditional Probability

Explore how Conditional probabilities are written like $P(A|B)$, which can be read to mean, "the probability that A happens GIVEN b has happened." (7 min)

Conditional Probability Explained Visually

Visualize how to do conditional probability. (5 min)

Conditional Probability Tree Diagram Example

Use a tree diagram to work out a conditional probability question. (11 min)

Conditional Probability and Independence

Use conditional probability to see if events are independent or not. (4 min)

Analyzing Event Probability for Independence

Use an example about shirts, scarves, hats, and pants to explain how to use probabilities to figure out if two events are independent. (7 min)

Counting Principal, Factorial, & Permutations

Count Outcomes Using Tree Diagram

Use tree diagrams to find the number of possible outcomes and calculate the probability of possible outcomes. (5 min)

Counting Outcomes: Flower Pots

Find the number of ways you can put four types of flowers into three types of pots. (3 min)

Permutation Formula

Learn about the permutation formula by solving seating arrangement problems with factorial notation and a general formula. (8 min)

Zero Factorial or 0!

Learn how Factorials are a quick way to represent multiplying a number by all the smaller positive integers down to one. (5 min)

Factorial and Counting Seat Arrangements

Learn how to use permutations to solve problems involving ways to arrange things. (6 min)

Possible Three Letter Words

Explain how to find all the possible three letter words when we can use each letter as many times as we want, and when each letter can only be used once. (6 min)

Ways to Arrange Colors

Explore about how many ways you can pick four colors from a group of 6. (4 min)

Ways to Pick Officers

Explore how many ways you can pick an officer. (2 min)

Combinations & Probability

Intro to Combinations

Learn the difference between permutations and combinations, using the example of seating six people in three chairs. (7 min)

Combination Formula

Learn the difference between permutations and combinations, and how to calculate them using factorials. (11 min)

Handshaking Combinations

Figure out how different combinations of people can shake hands. (7 min)

Combination Example: 9 Card Hands

Explore how many ways we can construct a hand of 9 cards. (8 min)

Probability using Combinations (Part 1)

Explore the Probability of getting exactly 3 heads in 8 flips of a fair coin. (9 min)

Probability using Combinations (Part 2)

Explore the Probability of getting exactly 3 heads in 8 flips of a fair coin. (11 min)

Example: Different Ways to Pick Officers

Explore the different ways we can pick officers in order to find the probability of one situation in particular. (3 min)

Example: Combinatorics and Probability

Explore the Probability of getting a set of cards. (12 min)

Getting Exactly Two Heads (Combinatorics)

Explore a different way to think about the probability of getting 2 heads in 4 flips. (10 min)

Exactly Three Heads in Five Flips

Discover the Probability of exactly 3 heads in 5 flips using combinations. (7 min)

Generalizing with Binomial Coefficients (Advanced)

Conceptual understanding of where the formula for binomial coefficients come from. (12 min)

Example: Lottery Probability

Explore the probability of winning a 4-number lottery. (5 min)

Conditional Probability and Combinations

Find the probability that a coin is flipped 4 heads out of 6 tosses. (17 min)

Mega Millions Jackpot Probability

Explore the probability of winning the Mega Millions jackpot. (6 min)

Birthday Probability Problem

Explore the probability that at least 2 people in a room of 30 share the same birthday. (13 min)

Random Variables: Discrete vs. Continuous

Random Variables

Discover the Basic idea and definitions of random variables. (6 min)

Discrete and Continuous Random Variables

Discrete random variables can only take on a finite number of values. Continuous random variables, on the other hand, can take on any value in each interval. (12 min)

Constructing a Probability

Distribution for Random Variable

Learn how to create the probability distribution of the number of "heads" after 3 flips of a fair coin. (7 min)

Probability Models Example: Frozen Yogurt

Model the probability of a frozen yogurt line having 0, 1, or 2 people in it. (8 min)

Valid Discrete Probability Distribution Examples

Explore examples on identifying valid discrete probability distributions. (4 min)

Probability with Discrete Random Variable Example

Explore example analyzing discrete probability distribution. (4 min)

Mean (Expected Value) of a Discrete Random Variable

Learn to calculate the mean (or expected value) of a discrete random variable as the weighted average of all the outcomes of that random variable based on their probabilities. (4 min)

Variance and Standard Deviation of a Discrete Random Variable

Find the variance and standard deviation of a discrete random variable. (6 min)

Probability Density Functions

Explore Probability density functions for continuous random variables. (10 min)

Probabilities from Density Curves

Explore Examples finding probabilities from probability distributions for continuous random variables. (5 min)

Transforming & Combining Random Variables

Impact of Transforming (Scaling and Shifting) Random Variables

Linear transformations (addition and multiplication of a constant) and their impacts on center (mean) and spread (standard deviation) of a distribution. (7 min)

Example: Transforming a Discrete Random Variable

Explore an example of transforming a discrete random variable. (4 min)

Mean of Sum and Difference of Random Variables

Discover the Mean of sum and difference of random variables. (4 min)

Variance of Sum and Difference of Random Variables

Intuition for why the variance of both the sum and difference of two independent random variables is equal to the sum of their variances. (8 min)

Intuition for Why Independence Matters for Variance of Sum

Intuition for why independence matters for variance of sum. (5 min)

Deriving the Variance of the Difference of Random Variables

Derive the variance of the difference of random variables. (11 min)

Example: Analyzing Distribution of Sum of Two Normally Distributed Random Variables

Find the probability that the total of some random variables exceeds an amount by understanding the distribution of the sum of normally distributed variables. (6 min)

Example: Analyzing the Difference in Distributions

Find the probability that a randomly selected woman is taller than a randomly selected man by understanding the distribution of the difference of normally distributed variables. (10 min)

Binomial Random Variables

Binomial Variables

Explore a special class of random variables called binomial random variables. (8 min)

Recognizing Binomial Variables

Explore examples and counterexamples of binomial variables. (7 min)

10% Rule of Assuming "Independence" Between Trials

Discover the 10% rule of assuming "independence" between trials. (7 min)

Binomial Distribution

Learn about binomial distribution with an example. (12 min)

Visualizing a Binomial Distribution

Graph a binomial distribution and connect it back to how to calculate binomial probabilities. (10 min)

Binomial Probability Example

Use the binomial distribution to find the probability of getting a certain number of successes, like successful basketball shots, out of a fixed number of trials. (10 min)

Generalizing K Scores in N Attempts

Generalize 2 scores in 6 attempts to k scores in n attempts. (4 min)

Free Throw Binomial Probability Distribution

Use the binomial distribution to calculate the probability of making different number of free throws. (9 min)

Graphing Basketball Binomial Distribution

Graph the results of using the binomial distribution to find the probabilities of making different numbers of free throws. (5 min)

Binompdf and Binomcdf Functions

Explore how to use a TI-84 (very similar for TI-85 or TI-89) calculator for making calculations regarding binomial random variables. (6 min)

Mean and Variance of Bernoulli

Distribution Example

Calculate the mean and variance of a Bernoulli distribution (in this example the responses are either favorable or unfavorable). (9 min)

Bernoulli Distribution Mean and Variance Formulas

Learn to derive the mean and variance formulas for the Bernoulli distribution. (7 min)

Expected Value of a Binomial Variable

Explore how to derive and use the expected value (mean) formula for binomial random variables. (7 min)

Variance of a Binomial Variable

Derive the variance of a binomial variable to be $p(1-p)$, and the standard deviation is the square root of the variance. (7 min)

Finding the Mean and Standard Deviation of a Binomial Random Variable

For a binomial random variable, the mean is n times p (np), where n is the sample size and p is the probability of success. The standard deviation is the square root of $np(1-p)$. We can use them to make predictions in a binomial setting. (5 min)

Geometric Random Variables & Expected Value

Geometric Random Variables Introduction

Distinguishing between geometric and binomial random variables. (7 min)

Probability for a Geometric Random Variable

Find the probability for a single outcome of a geometric random variable. (3 min)

Cumulative Geometric Probability (Greater than a Value)

Find the probability for a geometric random variable being greater than a certain value. (6 min)

Cumulative Geometric Probability (Less than a Value)

Find the probability for a geometric random variable being less than a certain value. (4 min)

Calculator Functions: Geometpdf and Geometcdf

Use a TI-84 (very similar for TI-85 or TI-89) calculator for making calculations regarding geometric random variables. (6 min)

Proof of Expected Value of Geometric Random Variable

Explore the Proof of expected value of geometric random variable. (4 min)

Getting Data from Expected Value

Explore how expected value refers to the average outcome you would expect from repeating an experiment over and over. (10 min)

Expected Profit from Lottery Ticket

Multiply the outcomes by probabilities to find the expected value of a lottery ticket. (9 min)

Expected Value while Fishing

Explore example where he multiplies probability by values and sums to find expected value. (9 min)

Comparing Insurance with Expected Value

Use expected value to compare a couple of different insurance policies. (9 min)

Law of Large Numbers

Explore the magic behind the law of large numbers. (9 min)

(Advanced) Poisson Distribution

Introduction to Poisson Distribution

Explore the Poisson Processes and the Poisson Distribution. (16 min)

Poisson Process (Part 1)

Explore the Poisson Processes and the Poisson Distribution more in-depth. (11 min)

Poisson Process (Part 2)

Explore the Poisson Processes and the Poisson Distribution more in-depth. (13 min)

Sampling Distributions

Introduction to Sampling Distributions

Learn about sampling distributions. (7 min)

Sample Statistic Bias Worked Example

Determine bias of sample statistics based on approximate sampling distributions example. (3 min)

Sampling Distribution of Sample Proportion (Part 1)

Explore the formulas for the mean and standard deviation of a sampling distribution of sample proportions. (10 min)

Sampling Distribution of Sample Proportion (Part 2)

Learn to build intuition for the sampling distribution of sample proportions using a simulation. (5 min)

Normal Conditions for Sampling

Distributions of Sample Proportions

Explore conditions for roughly normal sampling distribution of sample proportions. (6 min)

Probability of Sample Proportions Example

Explore this probability of sample proportions example. (7 min)

Inferring Population Mean from Sample Mean

Discover how to infer things about the greater population mean from a sample mean. (10 min)

Central Limit Theorem

Explore the central limit theorem and the sampling distribution of the mean. (10 min)

Sampling Distribution of the Sample Mean (Part 1)

Explore the main idea of the central limit theorem — the sampling distribution of the sample mean is approximately normal for "large" samples. (11 min)

Sampling Distribution of the Sample Mean (Part 2)

Examine the central limit theorem and the sampling distribution of the sample mean. (13 min)

Standard Error of the Mean

Explore what the standard error of the mean measures. (15 min)

Example: Probability of Sample Mean Exceeding a Value

Estimate the probability that the sample mean exceeds a given value in the sampling distribution of the sample mean. (15 min)

Confidence Intervals: Population Proportion

Confidence Intervals and Margin of Error

Use what we know about sampling distributions and margin of error to build a confidence interval to estimate the true value of the percentage in the population. (12 min)

Confidence Interval Simulation

Explore confidence interval simulation. (5 min)

Interpreting Confidence Level Example

Explore how to Interpret confidence level example. (5 min)

Confidence Interval Example

Calculate a 99% confidence interval for the proportion of teachers who felt computers are an essential tool. (19 min)

Margin of Error (Part 1)

Find the 95% confidence interval for the proportion of a population voting for a candidate. (16 min)

Margin of Error (Part 2)

Find the 95% confidence interval for the proportion of a population voting for a candidate. (10 min)

Conditions for Valid Confidence Intervals for a Proportion

Discover the conditions to satisfy the random, normal, and independent conditions for these confidence intervals to be valid. (7 min)

Conditions for Confidence Interval for a Proportion Worked Examples

Discover the conditions for confidence intervals for a population proportion worked examples-- random condition, independence condition and normal condition. (5 min)

Critical Value (z^*) for a Given Confidence Level

Learn to calculate a critical value z^* for any given confidence level using normal distribution calculations. (6 min)

Example Constructing and Interpreting a Confidence Interval for P

Learn to check conditions, calculate, and interpret a confidence interval to estimate a population proportion. (7 min)

Determining Sample Size Based on Confidence and Margin of Error

Determine sample size based on confidence level and margin of error. (8 min)

Confidence Intervals: Population Mean

Introduction to T Statistics

Discover why we use t statistics. (5 min)

Simulation Showing Value of T Statistic

Explore why we use t statistics when building confidence intervals for a mean using the sample standard deviation in place of the population standard deviation. (3 min)

Conditions for Valid T Intervals

Explore example showing how to determine if the conditions have been met for making a t interval to estimate a mean. (5 min)

Example Finding Critical T Value

Given a confidence level, we can calculate a critical value (t^*) in a t-distribution with $n-1$ degrees of freedom. (4 min)

Example Constructing a T Interval for a Mean

Explore example showing how to calculate a one-sample t interval for a mean. (6 min)

Confidence Interval for a Mean with Paired Data

Explore Confidence interval for a mean difference with paired data. (10 min)

Sample Size for a Given Margin of Error for a Mean

Calculate the approximate sample size required to obtain a desired margin of error in a confidence interval for a mean. (8 min)

T-Statistic Confidence Interval

Compute a confidence interval for the emission from an engine with a new design. (12 min)

Small Sample Size Confidence Intervals

Construct small sample size confidence intervals using t-distributions. (11 min)

The Idea of Significance Tests

Simple Hypothesis Testing

Explore an example about who should do the dishes that gets at the idea behind hypothesis testing. (6 min)

Idea Behind Hypothesis Testing

Discover the idea behind hypothesis testing. (8 min)

Examples of Null and Alternative Hypotheses

Explore examples of how the null hypothesis and alternative hypothesis are used. (6 min)

P-Values and Significance Tests

Compare a P-value to a significance level to make a conclusion in a significance test. (8 min)

Comparing P-Values to Different Significance Levels

Explore examples comparing P-values to different significance levels, and why it's important to set the significance level before a test. (5 min)

Estimating a P-Value from a Simulation

Solve this example of estimating a P-value based on a simulation to approximate a sampling distribution assuming the null hypothesis is true. (5 min)

Error Probabilities & Power

Introduction to Type I and Type II Errors

Learn how both type 1 and type 2 errors are mistakes made when testing a hypothesis. (5 min)

Type 1 Errors

Discover that a Type 1 error occurs when the null hypothesis is true, but we reject it because of a usual sample result. (3 min)

Examples Identifying Type I and Type II Errors

Explore these examples identifying Type I and Type II errors. (6 min)

Introduction to Power in Significance Tests

Explore the power in significance tests. (10 min)

Examples Thinking About Power in Significance Tests

Explore these examples thinking about power in significance tests. (4 min)

Tests About a Population Proportion

Constructing Hypotheses for a Significance Test About a Proportion

Explore how to construct a hypothesis for a significance test about a proportion. (4 min)

Conditions for a Z Test About a Proportion

Explore how to check whether the conditions have been met for doing a z test about a proportion. (5 min)

Calculating a Z Statistic in a Test About a Proportion

Explore how to calculate a z statistic in a one-sample z test about a proportion. (5 min)

Calculating a P-Value Given a Z Statistic

Calculate a test statistic based on our sample results. (5 min)

Making Conclusions in a Test About a Proportion

Explore this example of how to make a conclusion in a test about a proportion. (5 min)

Tests About a Population Mean

Writing Hypotheses for a Significance Test About a Mean

Explore this example of constructing hypotheses for a test about a mean. (3 min)

Conditions for a T Test About a Mean

Explore examples showing how to check which conditions have been met for a t test about a mean. (6 min)

When to Use Z or T Statistics in Significance Tests

Discover when to use z or t statistics in significance tests. (5 min)

Example Calculating T Statistic for a Test About a Mean

Explore an example of how to calculate t statistic for test about a mean. (5 min)

Using TI Calculator for P-Value from T Statistic

Calculate a test statistic based on our sample results. (3 min)

Using a Table to Estimate P-Value from T Statistic

Use a table to estimate the p-value based on that test statistic using a t distribution with n-1 degrees of freedom. (4 min)

Comparing P-Value from T Statistic to Significance Level

Explore this example showing how to compare the P-value to a significance level to make a conclusion in a t test. (4 min)

More on Significance Testing

Hypothesis Testing and P-Values

Explore an example about a neurologist testing the effect of a drug to discuss hypothesis testing and p-value. (11 min)

One-Tailed and Two-Tailed Tests

Discover the effect of a drug to one-tailed and two-tailed hypothesis tests. (7 min)

Z-Statistics vs. T-Statistics

Discover the difference between Z-statistics and T-statistics. (7 min)

Small Sample Hypothesis Test

Explore an example of a hypothesis test where we determine if there is sufficient evidence to conclude that a new type of engine meets emission requirements. (9 min)

Large Sample Proportion Hypothesis Testing

Use a large sample to test if more than 30% of US households have internet access. (15 min)

Two-Sample Inference for the Difference Between Groups

Comparing Population Proportions (Part 1)

Use an election example to compare population proportions. (11 min)

Comparing Population Proportions (Part 2)

Use an election example to compare population proportions. (10 min)

Hypothesis Test Comparing Population Proportions

Use election results to run a hypothesis test comparing population proportions. (17 min)

Statistical Significance of Experiment

Determine if the results of an experiment about advertising are statistically significant. (9 min)

Statistical Significance on Bus Speeds

Determine if the results of an experiment about bus speeds are statistically significant. (11 min)

Difference of Sample Means Distribution

Explore the difference of sample means distribution. (12 min)

Confidence Interval of Difference of Means

Use a confidence interval to help figure out if a low-fat diet helps obese people lose weight. (16 min)

Clarification of Confidence Interval of Difference of Means

Discover what clarification of confidence interval of difference of means covers.

(3 min)

Hypothesis Test for Difference of Means

Explore what the Hypothesis Test for Difference of Means is. (10 min)

Inference for Categorical Data (Chi-Square Tests)

Chi-Square Distribution Introduction

Explore what chi-square distribution is. (11 min)

Pearson's Chi Square Test (Goodness of Fit)

Use the chi square test to the hypothesis that the owner's distribution is correct. (12 min)

Chi-Square Statistic for Hypothesis Testing

Explore the chi-square statistic for hypothesis testing (chi-square goodness-of-fit test). (9 min)

Chi-Square Goodness-of-Fit Example

Solve this chi-square goodness-of-fit example. (7 min)

Filling out Frequency Table for Independent Events

Given the row and column totals, fill in the cells of a frequency table so that the events are independent. (5 min)

Contingency Table Chi-Square Test

Use the contingency table chi-square test to see if a couple of different herbs prevent people from getting sick. (17 min)

Introduction to the Chi-Square Test for Homogeneity

Discover the chi-square test for homogeneity. (8 min)

Chi-Square Test for Association (Independence)

Explore the Chi-square test for association/independence. (11 min)

Advanced Regression (Inference & Transforming)

Introduction to Inference About Slope in Linear Regression

Explore sample slopes and use them to make confidence intervals or do a test about the population slope in least-squares regression. (7 min)

Conditions for Inference on Slope

Discover the conditions for making a confidence interval or doing a test about slope in least-squares regression. (5 min)

Confidence Interval for the Slope of a Regression Line

Learn about confidence interval for the slope of a regression line. (7 min)

Calculating T Statistic for Slope of Regression Line

Calculate the test statistic in a test about the slope of a regression line. (7 min)

Using a P-Value to Make Conclusions in a Test About Slope

Make conclusions in a hypothesis test about the slope of a least-squares regression line. (6 min)

Using a Confidence Interval to Test Slope

Use confidence interval for hypothesis test on regression slope. (4 min)

Comparing Models to Fit Data Example

Determine if a quadratic or exponential model fits the data better, then uses the model to make a prediction. (4 min)

Transforming Nonlinear Data

Use logarithms to transform nonlinear data into a linear relationship so we can use least-squares regression methods. (3 min)

Worked Example of Linear Regression Using Transformed Data

Solve this example of linear regression using transformed data (8 min)

Analysis of Variance (ANOVA)

ANOVA 1: Calculating SST (Total Sum of Squares)

Analysis of variance 1 - calculating SST (total sum of squares). (8 min)

ANOVA 2: Calculating SSW and SSB (Total Sum of Squares Within and Between)

Analysis of variance 2 - calculating SSW and SSB (total sum of squares within and between). (14 min)

ANOVA 3: Hypothesis Test with F-Statistic

Analysis of variance 3 - hypothesis test with f-statistic. (10 min)

Measurement & Data | Charts & Graphs: Analyzing One Categorical Variable

Identifying Individuals, Variables and Categorical Variables in a Data Set

Identifying individuals, variables and categorical variables in a data set. (3 min)

Reading Pictographs

Explore how pictograph is basically a way to represent data with pictures that relate to the data. (3 min)

Reading Bar Graphs

Explore how to read a bar graph. (3 min)

Reading Bar Graphs: Harry Potter

Interpret a bar graph. (1 min)

Creating a Bar Graph

Create a bar chart using data from a survey. (1 min)

Reading Bar Charts: Comparing Two Sets of Data

Explore how a bar chart is especially useful with comparing two sets of data. (2 min)

Reading Bar Charts: Putting it Together with Central Tendency

Look at bar charts and using the information to determine the measures of central tendency. (5 min)

Reading Pie Graphs (Circle Graphs)

Explore how to read pie graphs (circle graphs). (3 min)

Measurement & Data | Two-Way Tables

Two-Way Frequency Tables and Venn Diagrams

Explore how to use Venn diagrams and two-way tables to categorize data. (6 min)

Two-Way Relative Frequency Tables

Explore how relative frequencies show how often something happens compared to the total number of times it could happen. (5 min)

Interpreting Two-Way Tables

Explore how two-way tables help us understand how categories relate. (2 min)

Categorical Data Example

Explore the relationship between two categorical variables with two-way tables to see if there is an association between the variables. (3 min)

Analyzing Trends in Categorical Data

Solve an example where he is asked to calculate relative frequencies and analyze trends in categorical data. (9 min)

Marginal and Conditional Distributions

Marginal distributions are totals for each row or column in a two-way table (or joint distribution table), showing the distribution of one variable. (5 min)

Measurement & Data | Displaying Quantitative Data with Graphs

Representing Data

Explore a few of the many ways to look at data. (8 min)

Frequency Tables & Dot Plots

Learn to organize data into frequency tables and dot plots (sometimes called line plots). (7 min)

Histograms

Explore how a histogram is a graphical display of data using bars of different heights. (6 min)

Creating a Histogram

Explore how to create a histogram. (7 min)

Interpreting a Histogram

Learn how to read and interpret histograms, which summarize data by sorting it into buckets. (5 min)

Stem-and-Leaf Plots

A stem and leaf is a table used to display data. The 'stem' is on the left and displays the first digit or digits. The 'leaf' is on the right and displays the last digit. (6 min)

Reading Stem and Leaf Plots

A stem and leaf plot display data by breaking each data point into two parts: the "stem" and the "leaf." (3 min)

Measurement & Data | Describing & Comparing Distributions

Shapes of Distributions

Some distributions are symmetrical, with data evenly distributed about the mean. Other distributions are "skewed," with data tending to the left or right of the mean. We sometimes say that skewed distributions have "tails". (5 min)

Clusters, Gaps, Peaks & Outliers

Examples looking at different features of distributions, such as clusters, gaps, peaks, and outliers for distributions. (7 min)

Comparing Distributions with Dot Plots (Example Problem)

Examine two distributions in dot plots to draw conclusions about the times of Olympic swimmers. (4 min)

Comparing Dot Plots, Histograms, and Box Plots

Solve practice problems where he thinks about which data displays would be helpful in which situations. (5 min)

Example: Comparing Distributions

Compare distributions using the features of shape, center, spread, and outliers. (7 min)

Reading Line Graphs

Explore how a line graph is a way to visually represent data, especially data that changes over time. (3 min)

Misleading Line Graphs

Explore misleading line graphs. (5 min)

Measurement & Data | Intro to Scatterplots

Constructing a Scatter Plot

Explore how to construct a scatter plot from this model. (3 min)

Example of Direction in Scatter Plots

Explore this example of scatter plots. (3 min)

Scatter Plot: Smokers

In a negative linear association, as one variable goes up, the other variable goes down at a constant rate. (3 min)

Bivariate Relationship Linearity, Strength and Direction

Describe a bivariate relationship's linearity, strength, and direction. (9 min)

Measurement & Data | Correlation & Trend Lines

Example: Correlation Coefficient Intuition

Explain the intuition behind correlation coefficients and does a problem where he matches correlation coefficients to scatter plots. (7 min)

Calculating Correlation Coefficient

The most common way to calculate the correlation coefficient (r) is by using technology, but using the formula can help us understand how r measures the direction and strength of the linear association between two quantitative variables. (13 min)

Fitting a Line to Data

Create a scatter plot and then fit a line to data on the median California family income. (8 min)

Estimating the Line of Best Fit Exercise

The "line of best fit" is a line that shows the pattern of data points. If we can find a good line, it means there is a linear trend. If not, it means there is no linear trend. (1 min)

Estimating with Linear Regression (Linear Models)

A line of best fit is a straight line that shows the relationship between two sets of data. We can use the line to make predictions. (3 min)

Line of Best Fit: Smoking in 1945

Explore this scatter plot that shows how many adults in America smoked from year to year. (5 min)

Measurement & Data | Least-Squares Regression & Fit

Introduction to Residuals and Least Squares Regression

Explore this introduction to residuals and least squares regression. (8 min)

Calculating Residual Example

Explore how to calculate residual example. (5 min)

Calculating the Equation of a Regression Line

Calculate the equation of a least-squares regression line. Intuition for why this equation makes sense. (8 min)

Interpreting Slope of Regression Line

Interpret the slope of regression line. (3 min)

Interpreting Y-Intercept in Regression Model

Interpret the y-intercept in regression model. (3 min)

Interpreting a Trend Line

Explore this graph shows how studying affects test scores. (4 min)

Residual Plots

Create and analyze residual plots based on regression lines. (6 min)

R-Squared or Coefficient of Determination

In linear regression, r -squared (also called the coefficient of determination) is the proportion of variation in the response variable that is explained by the explanatory variable in the model. (13 min)

Standard Deviation of Residuals or Root-Mean-Square Error (RMSE)

Standard deviation of the residuals are a measure of how well a regression line fits the data. It is also known as root mean square deviation or root mean square error. (7 min)

Interpreting Computer Regression Data

Explore how to interpret computer generated regression data to find the equation of a least-squares regression line. (5 min)

Impact of Removing Outliers on Regression Lines

Explore the impact of removing outliers on slope, y-intercept and r of least-squares regression lines. (6 min)

Measurement & Data | More on Regression

Squared Error of Regression Line

Explore the idea that one can find a line that minimizes the squared distances to the points. (7 min)

Proof (Part 1) Minimizing Squared Error to Regression Line

Explore this proof minimizing squared error to regression line. (11 min)

Proof (Part 2) Minimizing Squared Error to Regression Line

Explore this proof minimizing squared error to regression line. (10 min)

Proof (Part 3) Minimizing Squared Error to Regression Line

Explore this proof minimizing squared error to regression line. (11 min)

Proof (Part 4) Minimizing Squared Error to Regression Line

Explore this proof minimizing squared error to regression line. (4 min)

Regression Line Example

Explore this regression line example. (10 min)

Second Regression Example

Explore this second regression example. (9 min)

Calculating R-Squared

Learn to calculate r-squared to see how well a regression line fits data. (10 min)

Covariance and the Regression Line

Explore covariance, variance and the slope of the regression line. (15 min)

Pre-Calculus

Geometry | Special Trig Values & Identities

Trig Values of $\pi/4$

Find the trigonometric values of $\pi/4$ using the unit-circle definition. (8 min)

Cosine, Sine and Tangent of $\pi/6$ and $\pi/3$

Use the unit circle and the Pythagorean theorem, and find the exact sine, cosine, and tangent of the angles $\pi/6$ and $\pi/3$. (9 min)

Proof of the Pythagorean Trig Identity

The Pythagorean identity tells us that no matter what the value of θ is, $\sin^2\theta + \cos^2\theta$ is equal to 1. We can prove this identity using the Pythagorean theorem in the unit circle with $x^2 + y^2 = 1$. (6 min)

Using the Pythagorean Trig Identity

The Pythagorean identity tells us that no matter what the value of θ is, $\sin^2\theta + \cos^2\theta$ is equal to 1. This follows from the Pythagorean theorem, which is why it's called the Pythagorean identity! We can use this identity to solve various problems. (6 min)

Sine & Cosine Identities: Symmetry

Find several trigonometric identities for sine and cosine by considering horizontal and vertical symmetries of the unit circle. (8 min)

Tangent Identities: Symmetry

Find several trigonometric identities for tangent by considering horizontal and vertical symmetries of the unit circle. (7 min)

Sine & Cosine Identities: Periodicity

Find trigonometric identities for sine and cosine by considering angle rotations on the unit circle. (6 min)

Tangent Identities: Periodicity

Solve a problem by considering the periodicity of the tangent function. (4 min)

Geometry | Inverse Trigonometric Functions

Intro to Arcsine

Explore arcsine, which is the inverse function of sine, and discusses its principal range. (10 min)

Intro to Arctangent

Explore arctangent, which is the inverse function of tangent, and discusses its principal range. (10 min)

Intro to Arccosine

Explore arccosine, which is the inverse function of cosine, and discusses its principal range. (14 min)

Restricting Domains of Functions to Make Them Invertible

Given the graph of a trigonometric function, we discuss ways to change the function to make it invertible. (6 min)

Domain & Range of Inverse Tangent Function

Find the formula for the inverse function of $g(x) = \tan(x - 3\pi/2) + 6$ and determine the domain of that inverse function. (10 min)

Using Inverse Trig Functions with a Calculator

Explore the appropriate way to use the calculator to find an angle when its tangent value is given. (4 min)

Geometry | Law of Sines & Law of Cosines

Solving for a Side with the Law of Sines

Given a triangle with two angle measures and one side length, find all the missing side lengths and angle measures using the law of sines. (6 min)

Solving for an Angle with the Law of Sines

Given a triangle with two side lengths and one angle measure, find all the missing angle measures using the law of sine (6 min)

Proof of the Law of Sines

Explore a simple proof of the Law of Sines. (7 min)

Solving for a Side with the Law of Cosines

Learn how to use the law of cosines to find the missing side length of a triangle when given two side lengths and the contained angle measure. (4 min)

Solving for an Angle with the Law of Cosines

Given a triangle with all side lengths but no angle measure, find one of the angle measures using the law of cosines. (7 min)

Proof of the Law of Cosines

Explore a simple proof of the Law of Cosines. (9 min)

Trig Word Problem: Stars

Solve a word problem about the distance between stars using the law of cosines. (6 min)

Geometry | Sinusoidal Equations & Models

Solving Sinusoidal Equations of the Form $\sin(x)=d$

Find the expressions that together represent all possible solutions to the equation $\sin(x)=1/3$. (6 min)

Cosine Equation Algebraic Solution Set

Solve a cosine equation with an infinite number of solutions. Use trig identities to represent the whole solution set. (6 min)

Cosine Equation Solution Set in an Interval

Given the algebraic solution set for a cosine equation, find which solutions fall within an interval. (6 min)

Sine Equation Algebraic Solution Set

Solve a sine equation with an infinite number of solutions. Use trig identities to represent the whole solution set. (5 min)

Solving $\cos(\theta)=1$ and $\cos(\theta)=-1$

Solve the equations $\cos(\theta)=1$ and $\cos(\theta)=-1$ using the graph of $y=\cos(\theta)$. (5 min)

Interpreting Solutions of Trigonometric Equations

Starting from a context represented by a trigonometric function, interpret equations based on the function. (4 min)

Trig Word Problem: Modeling Daily Temperature

Solve a word problem about the annual change in temperature by solving a sinusoidal equation. (11 min)

Geometry | Angle Addition Identities

Trig Angle Addition Identities

Review 6 related trigonometric angle addition identities: $\sin(a+b)$, $\sin(a-c)$, $\cos(a+b)$, $\cos(a-b)$, $\cos(2a)$, and $\sin(2a)$. (11 min)

Using the Cosine Angle Addition Identity

Evaluate the cosine of the sum of 60° and another angle whose right triangle is given. (5 min)

Using the Cosine Double-Angle Identity

Explore how to use cosine double angle formula tells us that $\cos(2\theta)$ is always equal to $\cos^2\theta - \sin^2\theta$. (4 min)

Proof of the Sine Angle Addition Identity

Prove the identity $\sin(x+y) = \sin(x)\cos(y) + \cos(x)\sin(y)$. (8 min)

Proof of the Cosine Angle Addition Identity

Prove the identity $\cos(x+y) = \cos(x)\cos(y) - \sin(x)\sin(y)$. (6 min)

Proof of the Tangent Angle Sum and Difference Identities

Using the sine and cosine of the sum or difference of two angles, prove:
 $\tan(x+y) = (\tan(x) + \tan(y)) / (1 - \tan(x)\tan(y))$. (7 min)

Geometry | Using Trigonometric Identities

Finding Trig Values Using Angle Addition Identities

Find the value of $\sin(7\pi/12)$ by rewriting it as $\sin(\pi/3 + \pi/4)$ and then using the sine angle addition formula. (9 min)

Using the Tangent Angle Addition Identity

Find the tangent of $13\pi/12$ without a calculator using the tangent angle addition identity. (6 min)

Using Trig Angle Addition Identities: Finding Side Lengths

Given a drawing with two triangles and some side lengths, uses the sine angle addition identity in order to find a missing side length. (5 min)

Using Trig Angle Addition Identities: Manipulating Expressions

Given that $\cos(2\theta)=C$ and he uses the cosine double-angle identity to find an expression for $\sin(\theta)$. (6 min)

Using Trigonometric Identities

Learn how trigonometric identities like $\sin^2\theta+\cos^2\theta=1$ can be used to rewrite expressions in a different, more convenient way. (3 min)

Geometry | Conic Sections

Intro to Conic Sections

Explore the four conic sections and see how they are derived by intersecting planes with cones in certain ways. (11 min)

Intro to Ellipses

Learn all about ellipses. (14 min)

Ellipse Standard Equation from Graph

Given an ellipse on the coordinate plane, find its standard equation, which is an equation in the form $(x-h)^2/a^2+(y-k)^2/b^2=1$. (4 min)

Ellipse Graph from Standard Equation

Explore how to graph an ellipse when given its equation in standard form. (2 min)

Foci of an Ellipse from Equation

Explore how the radii and the foci of an ellipse relate to each other, and how we can use this relationship to find the foci from the equation of an ellipse. (14 min)

Intro to Hyperbolas

Explore the standard equation for hyperbolas, and how it can be used to determine the direction of the hyperbola and its vertices. (14 min)

Vertices & Direction of a Hyperbola (Example 1)

Pick the graph of $y^2/9-x^2/4=1$ based on the hyperbola's center, direction, & vertices. (5 min)

Vertices & Direction of a Hyperbola (Example 2)

Match an equation to a given graph of a hyperbola, based on the hyperbola's direction & vertices. (3 min)

Graphing Hyperbolas

Given the hyperbola equation $y^2/4-x^2/9=1$, determine the direction to which it opens and its vertices to draw its graph. (8 min)

Foci of a Hyperbola from Equation

Explore the foci of hyperbolas and show how they relate to hyperbola equations. (16 min)

Proof of the Hyperbola Foci Formula

Explore how to prove why, for the general hyperbola equation $x^2/a^2-y^2/b^2=1$, the focal length f forms the equation $f^2=a^2+b^2$ with the parameters a and b . (15 min)

Equation of a Hyperbola not Centered at the Origin

Analyze the hyperbola whose equation is $(x-1)^2/16-(y+1)^2/4=1$, and graphs. (11 min)

Algebra | Composite Functions

Intro to Composing Functions

Learn how to evaluate the composition of functions step by step, using examples with three different function definitions: $f(x)$, $g(t)$, and $h(x)$. (6 min)

Evaluating Composite Functions

Evaluate $(h \circ g)(-6)$ for $g(x)=x^2+5x-3$ and $h(y)=3(y-1)^2-5$. (4 min)

Evaluating Composite Functions: Using Tables

Given tables of values of the functions f and g , evaluate $f(g(0))$ and $g(f(0))$. (4 min)

Evaluating Composite Functions: Using Graphs

Given the graphs of the functions f and g , evaluate $g(f(-5))$. (3 min)

Finding Composite Functions

Through a worked example involving $f(x)=\sqrt{x^2-1}$ and $g(x)=x/(1+x)$, learn about function composition: the process of combining two functions to create a new function. (3 min)

Evaluating Composite Functions (Advanced)

Given that $h(x)=3x$ and $g(t)=-2t-2-h(t)$, find $h(g(8))$. (4 min)

Modeling with Composite Functions

Determine the correct functions to compose (and the correct order) to model a given relationship, and vice versa. (7 min)

Modeling with Composite Functions: Skydiving

Model the maximum speed of a skydiver, by using composing given formulas for the maximum speed as a function of parachute area and parachute area as a function of width. (4 min)

Meaningfully Composing Functions

Decide which composed functions make sense by checking that the value that one function passes to the other is the right kind of input. (4 min)

Algebra | Inverse Functions

Determining if a Function is Invertible

Learn how to build a mapping diagram for a finite function, and how to use this diagram to determine if the function is invertible. (4 min)

Restricting Domains of Functions to Make Them Invertible

Given the graph of a trigonometric function, determine ways to change the function to make it invertible. (6 min)

Reading Inverse Values from a Graph

Learn how to find the inverse of a function and how to graph it. (4 min)

Reading Inverse Values from a Table

Given a table of inputs and outputs for a function, evaluate the inverse function for a certain input. (2 min)

Verifying Inverse Functions from Tables

Explore Functions s and t are inverses if and only if $s(t(x))=x$ and $t(s(x))=x$ for every x -value in the domains. (5 min)

Using Specific Values to Test for Inverses

Learn how to determine if two functions are inverses. (4 min)

Verifying Inverse Functions by

Composition Compose $f(x)=(x+7)^3-1$ and $g(x)=\sqrt[3]{(x+1)}-7$, and determine if $f(g(x))=g(f(x))=x$ are inverses. (7 min)

Verifying Inverse Functions by

Composition: Not Inverse

Compose $f(x)=2x-3$ and $g(x)=\frac{1}{2}x+3$ and discover that $f(g(x)) \neq g(f(x)) \neq x$, which means the functions are not inverses. (4 min)

Algebra | Complex Numbers

Plotting Numbers on the Complex Plane

Discover the real and imaginary parts of complex numbers and see how they correspond to the horizontal and vertical axes. (2 min)

Distance & Midpoint of Complex Numbers

Find the distance between $(2+3i)$ and $(-5-i)$ and then he finds their midpoint on the complex plane. (6 min)

Intro to Complex Number Conjugates

Learn about the conjugate of complex numbers, how to add and divide using conjugates, and the key property that multiplying a complex number by its conjugate produces a real number. (8 min)

Complex Number Conjugates

Explore how to find the conjugate of a complex number, which is simply changing the sign of the imaginary part. (4 min)

Dividing Complex Numbers

Divide $(6+3i)$ by $(7-5i)$. (5 min)

Complex Numbers & Sum of Squares Factorization

Learn how expressions of the form x^2+y^2 can be factored into linear factors. (5 min)

Factoring Sum of Squares

Factor $36a^8+2b^6$ as $(6a^4-i\sqrt{2}b^3)(6a^4+i\sqrt{2}b^3)$. (3 min)

Factoring Polynomials Using Complex Numbers

Show how to factor a fourth-degree polynomial into linear factors using the sum-product rule and the sum of squares identity. (3 min)

Absolute Value of Complex Numbers

Find the absolute value of $(3-4i)$. (3 min)

Complex Numbers with the Same Modulus (Absolute Value)

Show how to determine which members in a set of complex numbers have the same modulus (or absolute value). (3 min)

Absolute Value & Angle of Complex Numbers

Find the modulus (which is the absolute value) and the argument (which is the angle) of $\sqrt{3}/2+1/2*i$. (13 min)

Polar & Rectangular Forms of Complex Numbers

Learn how to convert a complex number from rectangular form to polar form. (12 min)

Converting a Complex Number from Polar to Rectangular Form

Given a complex number in polar form, we can convert that number to rectangular form and plot it on the complex plane. (3 min)

Multiplying Complex Numbers Graphically Example: $-3i$

Learn to multiply complex numbers graphically on the complex plane by rotating and scaling. Multiplying a complex number z by $-3i$ rotates and scales z . (2 min)

Multiplying Complex Numbers Graphically Example: $-1-i$

Learn to multiply complex numbers graphically on the complex plane. (4 min)

Multiplying Complex Numbers in Polar Form

Learn to multiply two complex numbers in polar form by multiplying their moduli and adding their arguments. (3 min)

Dividing Complex Numbers in Polar Form

Learn to divide two complex numbers in polar form by dividing their moduli and subtracting their arguments. (3 min)

Taking and Visualizing Powers of a Complex Number

Given a complex number in rectangular form, we can convert it to polar form to show how to visualize powers of the complex number by scaling and rotating it by its own modulus and argument. (7 min)

Complex Number Equations: $x^3=1$

Find all complex solutions to the equation $x^3=1$. (12 min)

Algebra | The Fundamental Theorem of Algebra

The Fundamental Theorem of Algebra

Explore the fundamental theorem of algebra, which, as is reflected in its name, is a very important theorem about polynomials. (6 min)

Quadratics & the Fundamental Theorem of Algebra

Explore the proof of the fundamental theorem of algebra for any degree of polynomial. (7 min)

Number of Possible Real Roots of a Polynomial

Explore how the fundamental theorem of algebra can be used to determine how many real roots a given polynomial has. (4 min)

Algebra | Properties of Rational Functions

Reducing Rational Expressions to Lowest Terms

Learn how to simplify rational expressions, which are fractions with variable expressions in the numerator and denominator. (8 min)

End Behavior of Rational Functions

Analyze the end behavior of several rational functions, that together cover all case types of end behavior. (10 min)

Discontinuities of Rational Functions

Analyze two rational functions to find their vertical asymptotes & removable discontinuities. He distinguishes those from the zeros of the functions. (7 min)

Algebra | Graphs of Rational Functions

Graphing Rational Functions According to Asymptotes

Learn how to find removable discontinuities, horizontal asymptotes, and vertical asymptotes of rational functions. (11 min)

Graphs of Rational Functions: Y-Intercept

Pick the graph that matches $f(x)=(ax^m+bx+12)/(cx^m+dx+12)$ based on its y-intercept. (3 min)

Graphs of Rational Functions:

Horizontal Asymptote

Pick the graph that matches $f(x)=(-x^2+ax+b)/(x^2+cx+d)$ based on its horizontal asymptote. (3 min)

Graphs of Rational Functions:

Vertical Asymptotes

Pick the graph that matches $f(x)=g(x)/(x^2-x-6)$ (where $g(x)$ is a polynomial) based on its discontinuities. (6 min)

Graphs of Rational Functions: Zeros

Pick the graph that matches $f(x)=(2x^2-18)/g(x)$ (where $g(x)$ is a polynomial) based on its zeros. (8 min)

Algebra | Modeling with Rational Functions

Analyzing Structure Word Problem: Pet Store (Part 1)

Solve a word problem about the unknown number of bears, cats, and dogs in a pet store using visual reasoning. (6 min)

Analyzing Structure Word Problem: Pet Store (Part 2)

Solve a word problem about the unknown number of bears, cats, and dogs in a pet store using algebraic reasoning. (3 min)

Combining Mixtures Example

Figure out how much of two gasoline mixtures to combine to get gasoline with a certain concentration of ethanol. (6 min)

Rational Equations Word Problem: Combined Rates (Example 1)

Solve a word problem about the combined leaf-bagging rates of Ian and Kyandre, by creating a rational equation that models the situation. (6 min)

Rational Equations Word Problem: Combined Rates (Example 2)

Solve a word problem about the combined deck-staining rates of Anya and Bill, by creating a rational equation that models the situation. (6 min)

Rational Equations Word Problem: Eliminating Solutions

Solve a word problem about the combined pool-filling rates of two water hoses by creating a rational equation that models the situation. (8 min)

Reasoning About Unknown Variables

Given that $a > 0$, $b < 0$, and $a/b > a \cdot b$, explore what we can determine from the variables. (6 min)

Reasoning About Unknown Variables: Divisibility

Given the positive integers a , b , and c , where a is a multiple of c and $(a+b)/c$ is an integer. Is b necessarily a multiple of c ? (4 min)

Structure in Rational Expression

Analyze this expression to determine what's bigger: the value of that expression at some unknown c , or the number of times the expression is equal to 0. (5 min)

Algebra | Operations with Rational Expressions

Multiplying & Dividing Rational Expressions: Monomials

Multiply $(6x^3/5) \times (2/3x)$ and divides $(2x^4/7) \div (5x^4/4)$. (6 min)

Multiplying Rational Expressions

Multiply rational expressions, we multiply both numerators and multiply both denominators. (6 min)

Dividing Rational Expressions

Learn the steps to divide rational expressions. (7 min)

Adding & Subtracting Rational Expressions: Like Denominators

Add $6/(2x^2-7) + (-3x-8)/(2x^2-7)$ and subtracts $(9x^2+3)/(14x^2-9) - (-3x^2+5)/(14x^2-9)$. (4 min)

Intro to Adding Rational Expressions with Unlike Denominators

Rewrite $a/b+c/d$ as a single rational expression. (3 min)

Adding Rational Expression: Unlike Denominators

Learn how to add rational expressions with different denominators by finding a common denominator, multiplying the numerators and denominators by the same factors, and simplifying the result. (5 min)

Subtracting Rational Expressions: Unlike Denominators

Rewrite $(-5x)/(8x+7) - (6x^3)/(3x+1)$ as $(-48x^4 - 42x^3 - 15x^2 - 5x)/(8x+7)(3x+1)$. (5 min)

Least Common Multiple of Polynomials

Find the least common multiple (LCM) of $3z^3 - 6z^2 - 9z$ and $7z^4 + 21z^3 + 14z^2$. (7 min)

Subtracting Rational Expressions: Factored Denominators

Subtract two rational expressions whose denominators are factored. (5 min)

Subtracting Rational Expressions

Subtract and simplify $(a-2)/(a+2) - (a-3)/(a^2+4a+4)$. (5 min)

Algebra | Intro to Vectors

Intro to Vectors and Scalars

Explore some examples of scalars and vectors, including distance, displacement, speed, and velocity. (9 min)

Representing Quantities with Vectors

Vectors can represent real-world quantities where it's important to have both a magnitude and a direction. (3 min)

Interpreting Statements about Vectors

Interpret a mathematical statement about two vector quantities in terms of the real-world quantities they represent. (3 min)

Introduction to Vector Components

In the two-dimensional plane, we can describe them in an equivalent way, by thinking about the changes in x and y from the vector's tail to its head. (5 min)

Finding the Components of a Vector

Find the x and y -components of a vector given its graph. (3 min)

Comparing the Components of Vectors

Figure out which vectors have the same x -component given the graphs of 4 different vectors. (3 min)

Vector Magnitude from Graph

Find the magnitude of a vector given its graph. (4 min)

Vector Magnitude from Components

Find the magnitude of a vector given its components of $(5, -3)$. (3 min)

Vector Magnitude from Initial & Terminal Points

Explore the magnitude of a vector when what we're given about the vector is where it starts and where it ends. (6 min)

Algebra | Operations with Vectors

Scalar Multiplication: Component Form

Explore what happens graphically and to the components of a vector when we multiply it by a scalar. (6 min)

Scalar Multiplication: Magnitude and Direction

Analyze the magnitude and direction of vectors that are a result of scalar multiplication of a vector whose magnitude is given. (5 min)

Adding & Subtracting Vectors

Explore how to add vectors by adding their components, then explain the intuition behind adding vectors using a graph. (8 min)

Adding & Subtracting Vectors End-to-End

Build intuition behind adding and subtracting vectors visually and the "end-to-end" method. (7 min)

Parallelogram Rule for Vector Addition

The parallelogram rule says that if we place two vectors, so they have the same initial point, and then complete the vectors into a parallelogram, then the sum of the vectors is the directed diagonal that starts at the same point as the vectors. (3 min)

Subtracting Vectors End-to-End

Determine which diagram represents vector subtraction graphically. (2 min)

Subtracting Vectors with Parallelogram Rule

Learn to subtract two vectors, we simply add the first vector and the opposite of the second vector, i.e., $a+b=a+(-b)$. (3 min)

Vector Addition & Magnitude

Explain some interesting properties of the magnitude of vector sums. (6 min)

Algebra | Vector Direction & Magnitude

Direction of Vectors from Components: 1st & 2nd Quadrants

Find the direction angle of a vector in the first quadrant, then move onto a trickier one in the second quadrant. (9 min)

Direction of Vectors from Components: 3rd & 4th Quadrants

Find the direction angle of a vector in the third quadrant and a vector in the fourth quadrant. (7 min)

Vector Components from Magnitude & Direction

Find the components of a couple of vectors given in magnitude and direction form. (10 min)

Vector Components from Magnitude & Direction: Word Problem

Given the magnitudes and directions of the forces two people apply to a box, find the overall force that is applied in the direction of the target. (9 min)

Adding Vectors in Magnitude and Direction Form

Take two vectors given by magnitude and direction and find the magnitude and direction of their sum. (8 min)

Algebra | Vector Word Problems

Vector Word Problem: Resultant Velocity

Find the resultant velocity vector of a boat. (11 min)

Vector Word Problem: Hiking

Solve a word problem with vectors where he finds the total straight-line distance traveled over a few days. (7 min)

Vector Word Problem: Resultant Force

Find a resultant force vector using geometry, specifically the laws of sines and the laws of cosines. (8 min)

Algebra | Intro to Matrices

Intro to Matrices

Discover what matrices are and what they do. (5 min)

Using Matrices to Represent Data: Networks

Explore how Matrices are basically tables of numeric values. (6 min)

Using Matrices to Represent Data: Payoffs

Represent a game's payoffs: we represent the points each player gets in an elaborate version of rock, paper, scissors. (7 min)

Multiplying Matrices by Scalars

Define what it means to multiply a matrix by a scalar (in the world of matrices, a scalar is simply a regular number). (3 min)

Adding & Subtracting Matrices

Define what it means to add or subtract matrices. (6 min)

Using Matrices to Manipulate Data: Pet Store

Explore how we can use matrices. (4 min)

Using Matrices to Manipulate Data: Game Show

Learn how to manipulate matrices that represent the possible prizes in a game show. (4 min)

Algebra | Using Matrices for Transformation

Matrices as Transformations of the Plane

By telling us where the vectors $[1,0]$ and $[0,1]$ are mapped to, we can figure out where any other vector is mapped to. (8 min)

Working with Matrices as Transformations of the Plane

Learn how to connect geometric transformations like rotations, reflections, and dilations to specific matrices. (4 min)

Intro to Determinant Notation and Computation

Learn to define matrix determinant and learn about related notation. (4 min)

Interpreting Determinants in Terms of Area

The determinant of a 2x2 matrix tells us what the area of the image of a unit square would be under the matrix transformation. This, in turn, allows us to tell what the area of the image of any figure would be under the transformation. (4 min)

Finding Area of Figure After Transformation Using Determinant

Find the area of the image of a rectangle after a transformation defined by a given matrix. (2 min)

Proof: Matrix Determinant Gives Area of Image of Unit Square Under Mapping

Proof that the determinant of a 2x2 matrix gives the area of the image of the unit square under the mapping defined by the matrix. (4 min)

Using Matrices to Transform the Plane: Mapping a Vector

Explore how to find the image of a given vector under the transformation defined by a given matrix. (4 min)

Using Matrices to Transform the Plane: Composing Matrices

Explore how to find a single matrix that defines the same transformation as the composition of two other matrices. (5 min)

Using Matrices to Transform a 4D Vector

Explore how to find the image of a given 4D vector under the transformation defined by a given matrix. (6 min)

Composing 3x3 Matrices

Explore how to find the matrix transformation that is the composition of two other matrices. (4 min)

Algebra | Matrix Multiplication

Intro to Matrix Multiplication

Explain what it means to multiply two matrices and give an example. (6 min)

Multiplying Matrices

Explore an example of a multiplication of two matrices that don't have the same dimensions. (6 min)

Defined Matrix Operations

Discuss the conditions of matrix dimensions for which addition or multiplication are defined. (4 min)

Intro to Identity Matrix

Learn as any number remains the same when multiplied by 1, any matrix remains the same when multiplied by the identity matrix. (8 min)

Dimensions of Identity Matrix

Explain why the identity matrix is always a square matrix, even though it works with non-square matrices. (4 min)

Is Matrix Multiplication Commutative?

Explore whether the commutative property applies for matrix multiplication. In other words, he checks whether for any two matrices A and B, $A*B=B*A$ (the answer is NO, by the way). (8 min)

Algebra | Matrix Inverses

Inverse Matrix Introduction

Explore how the inverse of a square matrix is another matrix (of the same dimensions), where the multiplication (or composition) of the two matrices results in the identity matrix (7 min)

Invertible Matrices and Determinants

Investigate the relationship between a matrix's determinant, and whether that matrix is invertible. (5 min)

Invertible Matrices and Transformations

Compare the effect of two transformations, one defined by an invertible matrix and one by a non-invertible matrix. (6 min)

Inverse Matrices and Matrix Equations

Explore how we can solve systems of equations with matrices. (8 min)

Finding Inverses of 2x2 Matrices

Give an example of how to find the inverse of a given 2x2 matrix. (3 min)

Algebra | Matrices & System of Equations

Representing Systems of Equations with Matrices

Given a system of 3 linear equations with 3 variables, we can represent it with the equation $Ax=b$, where A is a 3x3 matrix, x is a 3D vector with the variables, and b is a constant 3D vector. (7 min)

Representing Systems of Any Number of Equations with Matrices

Explore how to represent a system of n equations and variables. The resulting equation will be $Ax=b$, where A is an $n \times n$ matrix, x is an $n \times 1$ unknown vector, and b is the $n \times 1$ constant vector. (5 min)

Inverse Matrices and Matrix Equations

Explore how we can solve systems of equations with matrices. (8 min)

Solving Linear Systems with Matrices

Solve that matrix equation using the inverse of the coefficient matrix. (7 min)

Algebra | Geometric Series

Geometric Series Introduction

Learn about geometric series and explore an example where a geometric series helps us describe a savings account balance. (6 min)

Geometric Sequence vs. Series

Explore how a geometric series is the sum of the terms of a geometric sequence (3 min)

Finite Geometric Series Formula

Explore what the finite geometric series formula is $a(1-r^n)/(1-r)$ and learn why it works. (7 min)

Worked Examples: Finite Geometric Series

Evaluate three geometric series (defined in various ways) using the finite geometric series formula $a(1-r^n)/(1-r)$. (7 min)

Geometric Series Word Problems: Swing

Find an expression for the total length and calculate it for a specific number of swings. (6 min)

Geometric Series Word Problems: Hike

Explore how to model the length of a hike with a geometric series. (7 min)

Algebra | Geometric Series with Summation Notation

Summation Notation

Learn how Sigma, Σ , is the standard notation for writing long sums. (4 min)

Geometric Series with Sigma Notation

Learn about geometric series and how they can be written in general terms and using sigma notation. (4 min)

Worked Example: Finite Geometric Series (Sigma Notation)

Evaluate the geometric series $\Sigma 2(3^k)$ for $k=0$ to 99 using the finite geometric series formula $a(1-r^n)/(1-r)$. (3 min)

Finite Geometric Series Word Problem: Social Media

Solve an example of using a geometric series to answer a fun word problem. (8 min)

Finite Geometric Series Word Problem: Mortgage

Figure out the formula for fixed mortgage payments using the sum of a geometric series. (18 min)

Algebra | The Binomial Theorem

Intro to the Binomial Theorem

The binomial theorem tells us how to expand expressions of the form $(a+b)^n$, for example, $(x+y)^7$. (13 min)

Pascal's Triangle and Binomial Expansion

Learn about Pascal's triangle and how we use it to figure out the coefficients in binomial expansions. (8 min)

Expanding Binomials

Expand $(3y^2+6x^3)^5$ using the binomial theorem and Pascal's triangle. (9 min)

Expanding Binomials without Pascal's Triangle

Discover this "trick" for expanding large powers of binomials, without using Pascal's triangle. (5 min)

Binomial Expansion & Combinatorics

Explore why we use the combinatorial formula for $(n \text{ choose } k)$ to expand binomial expressions. (5 min)

Pascal's Triangle & Combinatorics

Discover how generating the values in Pascal's triangle is related to the combinatorial formula $(n \text{ choose } k)$. (4 min)

Algebra | Arithmetic Series

Arithmetic Series Intro

Explore the formula for the sum of a finite arithmetic series. (4 min)

Arithmetic Series Formula

Learn how to write an arithmetic sequence in general terms, using a common difference d and a first term a . (8 min)

Worked Example: Arithmetic Series (Sigma Notation)

Evaluate the arithmetic series $\Sigma(2k+50)$ for $k=1$ to 550. (7 min)

Worked Example: Arithmetic Series (Sum Expression)

Evaluate the arithmetic sum $(-50)+(-44)+(-38)+\dots+2044$. (7 min)

Worked Example: Arithmetic Series (Recursive Formula)

Evaluate the sum of the first 650 terms in the sequence defined recursively as $\{a_i=a_{i-1}+11, a_1=4\}$. (6 min)

Proof of Finite Arithmetic Series Formula

Prove the expression for the sum of all positive integers up to and including n . (4 min)

Algebra | Intro to Limits

Limits Intro

Learn about limits, a fundamental concept in calculus. (12 min)

Estimating Limit Values from Graphs

Learn to estimate limit values from graphs by observing the function's behavior as x approaches a value from both left and right sides. (6 min)

Unbounded Limits

Explore estimating limit values from graphs, focusing on two functions: $y = 1/x^2$ and $y = 1/x$. (3 min)

One-Sided Limits from Graphs

Discover a one-sided limit is the value the function approaches as the x -values approach the limit from *one side only*. (10 min)

One-Sided Limits from Graphs: Asymptote

Explore estimating one-sided limit values from graphs. (3 min)

Connecting Limits and Graphical Behavior

Explore how a description of a limit can apply to multiple different functions. (6 min)

Approximating Limits Using Tables

Learn about estimating limit values from tables. (5 min)

Estimating Limits from Tables

Given a table of values for a function, estimate the limit at a certain point by observing the values the function approaches from both sides. (4 min)

One-Sided Limits from Tables

Explore one-sided limits using tables, focusing on estimating the value a function approaches from either the left or right. (7 min)

Algebra | Methods for Finding Limits

Limit Properties

Discover limit properties, which are intuitive rules that help simplify limit problems. (5 min)

Limits of Combined Functions

Learn how to find the limit of combined functions using algebraic properties of limits. (4 min)

Limits of Combined Functions: Piecewise Functions

Analyze left and right-hand limits, determine if the limit of the combined functions exists and find its value. (4 min)

Theorem for Limits of Composite Functions

Find the limit of composite functions, specifically the limit as ' x ' approaches ' a ' of $f(g(x))$. (3 min)

Theorem for Limits of Composite Functions: When Conditions Aren't Met

Learn to find limit of the composite function $f(g(x))$ at $x=a$. (4 min)

Limits of Composite Functions: Internal Limit Doesn't Exist

Find the limit of $g(h(x))$ at $x=-1$ when the limit of $h(x)$ at $x=-1$ doesn't exist. (4 min)

Limits of Composite Functions: External Limit Doesn't Exist

Find the limit of $g(h(x))$ at $x=1$ when the limit of $h(x)$ at $x=1$ is 2 and the limit of $g(x)$ at $x=2$ doesn't exist. (4 min)

Limits by Direct Substitution

Learn to find the limits of functions at points where the functions are continuous: simply plug in the x -value into the function. (2 min)

Undefined Limits by Direct Substitution

Explore an example of a limit where direct substitution ends in a quotient with 0 in the denominator and non-0 in the numerator. (2 min)

Limits of Trigonometric Functions

Explore limits of trigonometric functions, focusing on sine, cosine, and tangent. (6 min)

Limits of Piecewise Functions

Explore limits of piecewise functions using algebraic properties of limits and direct substitution. (4 min)

Limits of Piecewise Functions: Absolute Value

Find the limit of $|x-3|/(x-3)$ at $x=3$ by rewriting it and examining it as a piecewise function. (6 min)

Limits by Factoring

Explore the limit of $(x^2+x-6)/(x-2)$ as x approaches 2. (6 min)

Limits by Rationalizing

Explore how to find the limit of a function as x approaches -1. (10 min)

Trig Limit Using Pythagorean Identity

Explore finding the limit as θ approaches 0 for the expression $(1-\cos\theta)/(2\sin^2\theta)$. (7 min)

Trig Limit Using Double Angle Identity

Find the limit at $\theta=-\pi/4$ of $(1+\sqrt{2}\sin\theta)/(\cos 2\theta)$ by employing trigonometric identities. (11 min)

Strategy in Finding Limits

Explore strategies for determining which technique to use when finding limits. (13 min)

Squeeze Theorem (Sandwich Theorem) Intro

Discover that the squeeze (or sandwich) theorem states that if $f(x) \leq g(x) \leq h(x)$ for all numbers, and at some point $x=k$ we have $f(k)=h(k)$, then $g(k)$ must also be equal to them. (7 min)

Limit of $\sin(x)/x$ as x Approaches 0

Prove that the limit of $\sin(\theta)/\theta$ as θ approaches 0 is equal to 1. (9 min)

Limit of $(1-\cos(x))/x$ as x Approaches 0

Explore the limit of $(1-\cos(x))/x$ as x approaches 0 and show that it equals 0. (4 min)

Algebra | Limits & Continuity

Types of Discontinuities

Explore how a function being continuous at a point means that the two-sided limit at that point exists and is equal to the function's value. (7 min)

Continuity at a Point

Discover how saying a function f is continuous when $x=c$ is the same as saying that the function's two-side limit at $x=c$ exists and is equal to $f(c)$. (8 min)

Worked Example: Continuity at a Point (Graphical)

Explore the necessary conditions for continuity at a point using graphical representations of functions. (7 min)

Worked Example: Point Where a Function is Continuous

Find the limit of a piecewise function at the point between two different cases of the function. (4 min)

Worked Example: Point Where a Function Isn't Continuous

Find the limit of a piecewise function at the point between two different cases of the function. (4 min)

Continuity Over an Interval

Explore how function f is continuous over the open interval (a,b) if and only if it's continuous on every point in (a,b) . (9 min)

Functions Continuous on All Real Numbers

Discover how to determine if a function is continuous on all real numbers by examining two examples: e^x and \sqrt{x} . Generally, common functions exhibit continuity within their domain. (3 min)

Functions Continuous at Specific X-Values

Determine the continuity of two functions, $\ln(x-3)$ and $e^{(x-3)}$, at $x=3$. Explore the concept of continuity, highlighting that common functions are continuous within their domain. (4 min)

Removing Discontinuities (Factoring)

Find the value the function $f(x)=(6x^2+18x+12)/(x^2-4)$ should have at $x=-2$ so it's continuous at that point. (4 min)

Removing Discontinuities (Rationalization)

Find the value the function $f(x)=(\sqrt{x+4}-3)/(x-5)$ should have at $x=5$ so it's continuous at that point. (5 min)

Algebra | Infinite Limits & Asymptotes

Introduction to Infinite Limits

Explore the notation of infinite limits. (4 min)

Infinite Limits and Asymptotes

Discover that Unbounded limits are represented graphically by vertical asymptotes and limits at infinity are represented graphically by horizontal asymptotes. (4 min)

Analyzing Unbounded Limits: Rational Function

Analyze the behavior of $f(x)=-1/(x-1)^2$ around its asymptote at $x=1$. (5 min)

Analyzing Unbounded Limits: Mixed Function

Analyze the behavior of $f(x)=x/[1-\cos(x-2)]$ around its asymptote at $x=2$. (6 min)

Introduction to Limits at Infinity

Explore the idea and notion of limits at infinity (and negative infinity). (3 min)

Functions with Same Limit at Infinity

Explore how a limit at infinity (like any other limit) describes the behavior of a function but it isn't unique to that function. (4 min)

Limits at Infinity of Quotients (Part 1)

Find the limits at positive and negative infinity of $(4x^5-3x^2+3)/(6x^5-100x^2-10)$. (4 min)

Limits at Infinity of Quotients (Part 2)

Analyze the limits at infinity of three different rational functions. (4 min)

Limits at Infinity of Quotients with Square Roots (Odd Power)

Find the limits at positive and negative infinity of $x/\sqrt{x^2+1}$. (5 min)

Limits at Infinity of Quotients with Square Roots (Even Power)

Discover the Limit at infinity of rational expression with radical. (4 min)

Algebra | Intermediate Value Theorem

Intermediate Value Theorem

Discover the intermediate value theorem, a fundamental concept in calculus that states if a function is continuous over a closed interval $[a, b]$, it encompasses every value between $f(a)$ and $f(b)$ within that range. (8 min)

Worked Example: Using the Intermediate Value Theorem

Discover how the intermediate value theorem guarantees specific outcomes for continuous functions. (7 min)

Justification with the Intermediate Value Theorem: Table

Explore this example justifying the use of the intermediate value theorem (where the function is defined with a table). (6 min)

Justification with the Intermediate Value Theorem: Equation

Explore this example justifying use of intermediate value theorem (where function is defined with an equation). (4 min)

Statistics & Probability | Addition & Multiplication Rules for Probability

Probability with Venn Diagrams

Explore the probability of drawing a Jack or a Heart from a deck of 52 cards. It uses a Venn diagram to illustrate the concept of overlapping events and how to calculate the combined probability. (10 min)

Addition Rule for Probability

Explore Venn diagrams and the addition rule for probability. (11 min)

Compound Probability of Independent Events

Learn how to calculate probabilities of coin flips using two methods: listing all possible outcomes or multiplying independent events. (6 min)

Independent Events Example: Test Taking

Discover the probability of two independent events occurring. (5 min)

General Multiplication Rule Example: Independent Events

Use the general multiplication rule to find the probability that two events both occur when the events are independent. (3 min)

Dependent Probability Introduction

Explore dependent probability using a scenario involving a casino game. (7 min)

General Multiplication Rule Example: Dependent Events

Use the general multiplication rule to find the probability that two events both occur when the events are not independent. (3 min)

Interpreting General Multiplication Rule

Express the probability that two events both occur symbolically using the general multiplication rule, and we can interpret probability statements that are expressed symbolically. (5 min)

Using Probabilities to Make Fair Decisions Example

Determine whether probabilities are being used to make a fair decision. (4 min)

Statistics & Probability | Permutations

Factorial and Counting Seat Arrangements

Learn how to use permutations to solve problems involving ways to arrange things. (6 min)

Permutation Formula

Explore this useful technique by solving seating arrangement problems with factorial notation and a general formula. (8 min)

Possible Three Letter Words

Explain how to find all the possible three letter words when we can use each letter as many times as we want, and when each letter can only be used once. (6 min)

Zero Factorial or 0!

Learn that factorials are a quick way to represent multiplying a number by all the smaller positive integers down to one. This video also shows why mathematicians have defined zero factorial as one, instead of zero, to make the formula for permutations work in all cases. (5 min)

Ways to Arrange Colors

Explore how many ways you can pick four colors from a group of 6. (4 min)

Ways to Pick Officers

Explore how many ways we can pick officers for our organization in this problem. (3 min)

Statistics & Probability | Combinations

Intro to Combinations

Learn the difference between permutations and combinations, using the example of seating six people in three chairs. (7 min)

Combination Formula

Learn the difference between permutations and combinations, and how to calculate them using factorials. (12 min)

Handshaking Combinations

Explore how different combinations of people can shake hands. (8 min)

Combination Example: 9 Card Hands

Explore how many ways we can construct a hand of 9 cards. (8 min)

Statistics & Probability | Probability Using Combinatorics

Probability Using Combinations

Explore the probability of getting exactly 3 heads in 8 flips of a fair coin. (9 min)

Example: Lottery Probability

Discover what the probability of winning a 4-number lottery is. (5 min)

Example: Different Ways to Pick Officers

Explore the different ways we can pick officers to find the probability of one situation in particular. (2 min)

Probability with Permutations &

Combinations Example: Taste Testing

Learn to use combinations (when order does not matter) and permutations (when order does matter) to find probabilities. (4 min)

Probability with Combinations Example: Choosing Groups

Use two combinations (when order does not matter) to find the probability of someone being included in the group that's chosen at random from a larger group created. (4 min)

Probability with Combinations Example: Choosing Cards

Use combinations (when order does not matter) to find the probability of drawing two aces and two kings in a draw of four cards. (3 min)

Mega Millions Jackpot Probability

Explore the probability of winning the mega millions jackpot. (6 min)

Statistics & Probability | Probability Distributions

Constructing a Probability

Distribution for Random Variable

Learn how to create the probability distribution of the number of "heads" after 3 flips of a fair coin. (7 min)

Valid Discrete Probability Distribution Examples

Explore examples on identifying valid discrete probability distributions. (4 min)

Probability with Discrete Random Variable Example

Analyze discrete probability distribution. (4 min)

Theoretical Probability Distribution

Example: Tables

Learn to create the probability distribution for rolling two dice by creating a table to represent the events that make up the sample space. (3 min)

Theoretical Probability Distribution

Example: Multiplication

Learn to create a probability distribution for the number of times someone wins a prize using the multiplication rule. (3 min)

Probability Distributions from Empirical Data

Learn to approximate a probability distribution by using empirical or observed data. (3 min)

Statistics & Probability | Expected Value

Mean (Expected Value) of a Discrete Random Variable

Learn to calculate the mean (or expected value) of a discrete random variable as the weighted average of all the outcomes of that random variable based on their probabilities. (5 min)

Interpreting Expected Value

Explore how to interpret expected value as a long-term average outcome. (3 min)

Expected Payoff Example: Lottery Ticket

Find the expected payoff (or the expected net gain) of a certain lottery ticket by taking the weighted average the outcomes. (4 min)

Expected Payoff Example: Protection Plan

Find the expected payoff (or the expected net gain) of a protection plan offered by a store by taking the weighted average of the outcomes. (3 min)

Calculus

Limits | Intro to Limits

Limits Intro

Learn about limits, a fundamental concept in calculus. (12 min)

Estimating Limit Values from Graphs

Learn to estimate limit values from graphs by observing the function's behavior as x approaches a value from both left and right sides. (7 min)

Unbounded Limits

Explore estimating limit values from graphs, focusing on two functions: $y = 1/x^2$ and $y = 1/x$. For $y = 1/x^2$, the limit is unbounded as x approaches 0, since the function increases without bound. (3 min)

One-Sided Limits from Graphs

Explore how a one-sided limit is the value the function approaches as the x -values approach the limit from *one side only*. (9 min)

One-Sided Limits from Graphs: Asymptote

Explore estimating one-sided limit values from graphs. (3 min)

Connecting Limits and Graphical Behavior

Analyze a function's limits from its graph, we are looking at the more "interesting" points. (5 min)

Approximating Limits Using Tables

Analyze various 1- and 2-sided limits of a function given graphically. (5 min)

Estimating Limits from Tables

Given a table of values for a function, estimate the limit at a certain point by observing the values the function approaches from both sides. (4 min)

One-Sided Limits from Tables

Explore one-sided limits using tables, focusing on estimating the value a function approaches from either the left or right. (6 min)

Limits | Methods for Finding Limits

Limit Properties

Discover limit properties, which are intuitive rules that help simplify limit problems. (5 min)

Limits of Combined Functions Learn how to find the limit of combined functions using algebraic properties of limits. (4 min)

Limits of Combined Functions: Piecewise Functions

Discover that even when individual limits of functions $f(x)$ and $g(x)$ don't exist, the limit of their sum or product might still exist. (4 min)

Theorem for Limits of Composite Functions

Find the limit of composite functions, specifically the limit as 'x' approaches 'a' of $f(g(x))$. (3 min)

Theorem for Limits of Composite Functions: When Conditions Aren't Met

Find the limit of the composite function $f(g(x))$ at $x=a$. (3 min)

Limits of Composite Functions: Internal Limit Doesn't Exist

Find the limit of $g(h(x))$ at $x=-1$ when the limit of $h(x)$ at $x=-1$ doesn't exist. (4 min)

Limits of Composite Functions: External Limit Doesn't Exist

Find the limit of $g(h(x))$ at $x=1$ when the limit of $h(x)$ at $x=1$ is 2 and the limit of $g(x)$ at $x=2$ doesn't exist. (3 min)

Limits by Direct Substitution

Discover how to find limits of functions at points where the functions are continuous: simply plug in the x-value into the function. (2 min)

Undefined Limits by Direct Substitution

Explore an example of a limit where direct substitution ends in a quotient with 0 in the denominator and non-0 in the numerator. (2 min)

Limits of Trigonometric Functions

Discover limits of trigonometric functions, focusing on sine, cosine, and tangent. (6 min)

Limits of Piecewise Functions

Explore limits of piecewise functions using algebraic properties of limits and direct substitution. (4 min)

Limits of Piecewise Functions: Absolute Value

Find the limit of $|x-3|/(x-3)$ at $x=3$ by rewriting it and examining it as a piecewise function. (6 min)

Limits by Factoring

Explore the limit of $(x^2+x-6)/(x-2)$ as x approaches 2. (6 min)

Limits by Rationalizing

Explore how to find the limit of a function as x approaches -1. (10 min)

Trig Limit Using Pythagorean Identity

Explore finding the limit as θ approaches 0 for the expression $(1-\cos\theta)/(2\sin^2\theta)$. (7 min)

Trig Limit Using Double Angle Identity

Find the limit at $\theta=-\pi/4$ of $(1+\sqrt{2}\sin\theta)/(\cos 2\theta)$ by employing trigonometric identities. (11 min)

Strategy in Finding Limits

Explore strategies for determining which technique to use when finding limits. (13 min)

Squeeze Theorem (Sandwich Theorem) Intro

Discover that the squeeze (or sandwich) theorem states that if $f(x) \leq g(x) \leq h(x)$ for all numbers, and at some point, $x=k$ we have $f(k)=h(k)$, then $g(k)$ must also be equal to them. (7 min)

Limit of $\sin(x)/x$ as x Approaches 0

Prove that the limit of $\sin(\theta)/\theta$ as θ approaches 0 is equal to 1. (9 min)

Limit of $(1-\cos(x))/x$ as x Approaches 0

Explore the limit of $(1-\cos(x))/x$ as x approaches 0 and show that it equals 0. (4 min)

Limits | Limits & Continuity

Types of Discontinuities

Explore the different types of discontinuities. (7 min)

Continuity at a Point

Discover how saying a function f is continuous when $x=c$ is the same as saying that the function's two-side limit at $x=c$ exists and is equal to $f(c)$. (8 min)

Worked Example: Continuity at a Point (Graphical)

Explore the necessary conditions for continuity at a point using graphical representations of functions. (7 min)

Worked Example: Point Where a Function is Continuous

Find the limit of a piecewise function at the point between two different cases of the function. (4 min)

Worked Example: Point Where a Function Isn't Continuous

Find the limit of a piecewise function at the point between two different cases of the function. (4 min)

Continuity Over an Interval

Discover that A function f is continuous over the open interval (a,b) if and only if it's continuous on every point in (a,b) . (9 min)

Functions Continuous on All Real Numbers

Discover how to determine if a function is continuous on all real numbers by examining two examples: e^x and \sqrt{x} . (3 min)

Functions Continuous at Specific X-Values

Explore the concept of continuity, highlighting that common functions are continuous within their domain. (4 min)

Removing Discontinuities (Factoring)

Find the value the function $f(x)=(6x^2+18x+12)/(x^2-4)$ should have at $x=-2$ so it's continuous at that point. (5 min)

Removing Discontinuities (Rationalization)

Find the value the function $f(x)=(\sqrt{x+4}-3)/(x-5)$ should have at $x=5$ so it's continuous at that point. (5 min)

Limits | Infinite Limits & Asymptotes

Introduction to Infinite Limits

Discover the notation of infinite limits. (4 min)

Infinite Limits and Asymptotes

Explore unbounded limits are represented graphically by vertical asymptotes and limits at infinity are represented graphically by horizontal asymptotes. (4 min)

Analyzing Unbounded Limits:

Rational Function

Analyze the behavior of $f(x)=-1/(x-1)^2$ around its asymptote at $x=1$. (5 min)

Analyzing Unbounded Limits:

Mixed Function

Analyze the behavior of $f(x)=x/[1-\cos(x-2)]$ around its asymptote at $x=2$. (6 min)

Introduction to Limits at Infinity

Explore the idea and notion of limits at infinity (and negative infinity). (3 min)

Functions with Same Limit at Infinity

Discover that a limit at infinity (like any other limit) describes the behavior of a function but it isn't unique to that function. (4 min)

Limits at Infinity of Quotients (Part 1)

Find the limits at positive and negative infinity of $(4x^5-3x^2+3)/(6x^5-100x^2-10)$. (4 min)

Limits at Infinity of Quotients (Part 2)

Analyze the limits at infinity of three different rational functions. (5 min)

Limits at Infinity of Quotients with Square Roots (Odd Power)

Find the limits at positive and negative infinity of $x/\sqrt{x^2+1}$. (5 min)

Limits at Infinity of Quotients with Square Roots (Even Power)

Discover the Limit at infinity of rational expression with radical. (4 min)

Limits | Intermediate Value Theorem

Intermediate Value Theorem

Discover the intermediate value theorem, a fundamental concept in calculus that states if a function is continuous over a closed interval $[a, b]$, it encompasses every value between $f(a)$ and $f(b)$ within that range. (8 min)

Worked Example: Using the Intermediate Value Theorem

Discover how the intermediate value theorem guarantees specific outcomes for continuous functions. (7 min)

Justification with the Intermediate Value Theorem: Table

Explore this example justifying the use of the intermediate value theorem (where the function is defined with a le). (6 min)

Justification with the Intermediate Value Theorem: Equation

Explore this example justifying use of intermediate value theorem (where function is defined with an equation). (4 min)

Limits | Formal Definition of Limits

Formal Definition of Limits Part 1:

Intuition Review

Enhance your understanding of this fundamental concept by reviewing how function values approach a specific limit as the input variable gets closer to a certain point. (4 min)

Formal Definition of Limits Part 2: Building the Idea

Explore the rigorous mathematical definition of a limit as x approaches c , and understand how to get $f(x)$ as close to L as desired by finding a range around c . (6 min)

Formal Definition of Limits Part 3: The Definition

Explore the epsilon-delta definition of limits, which states that the limit of $f(x)$ at $x=c$ equals L if, for any $\epsilon > 0$, there's a $\delta > 0$ ensuring that when the distance between x and c is less than δ , the distance between $f(x)$ and L is less than ϵ . (7 min)

Formal Definition of Limits Part 4: Using the Definition

Explore the epsilon-delta definition of limits in calculus, as we rigorously prove a limit exists for a piecewise function. (9 min)

Differentiation | Defining Average & Instantaneous Rates of Change at a Point

Newton, Leibniz, and Usain Bolt

Uncover the connection between Newton and Leibniz's pioneering work and Usain Bolt's impressive sprinting speeds, while grasping the significance of determining instantaneous velocity in diverse situations (9 min)

Derivative as a Concept

Learn about derivatives as the instantaneous rate of change and the slope of the tangent line. (7 min)

Secant Lines & Average Rate of Change

Learn how to calculate the average rate of change for a function and its connection to the slope of a secant line. (5 min)

Derivative as Slope of Curve

Explore how to interpret the derivative of a function at a specific point as the curve's slope or the tangent line's slope at that point. (6 min)

The Derivative & Tangent Line Equations

Discover how the derivative of a function reveals the slope of the tangent line at any point on the graph. (8 min)

Differentiation | Defining the Derivative of a Function & Using Derivative Notation

Formal Definition of the Derivative as a Limit

Discover how to define the derivative of a function at a specific point using the limit of the slope of the secant line. (16 min)

Formal and Alternate Form of the Derivative

Discover the two methods for defining the derivative of a function at a specific point using limit expressions. (5 min)

Worked Example: Derivative as a Limit

Discover how to apply the formal and alternate forms of the derivative in real-world scenarios. (6 min)

Worked Example: Derivative from Limit Expression

Explore a limit expression and discover that it represents the derivative of the function $f(x) = x^3$ at the point $x = 5$. (5 min)

The Derivative of x^2 at $x=3$ Using the Formal Definition

Learn to calculate the slope of the tangent line at a specific point on the curve $y=x^2$ by applying the limit as the change in x approaches zero. (9 min)

The Derivative of x^2 at Any Point Using the Formal Definition

Learn to apply the limit as h approaches 0 to determine the slope of the tangent line at a given point on the curve $y = x^2$. (11 min)

Estimating Derivatives

Estimate the derivative at a point using the slope of a secant line connecting points around that point. (6 min)

Differentiation | Differentiability & Continuity

Differentiability and Continuity

Explore differentiability and get an intuition for the relationship between differentiability and continuity. (10 min)

Differentiability at a Point: Graphical

Explore examples of functions and their graphs, focusing on finding points where the function isn't differentiable. (6 min)

Differentiability at a Point: Algebraic (Function is Differentiable)

Examine a piecewise function to determine its continuity and differentiability at an edge point. (5 min)

Differentiability at a Point: Algebraic (Function Isn't Differentiable)

Examine a piecewise function to determine its differentiability and continuity at an edge point. (6 min)

Differentiation | Basic Derivative Rules

Power Rule

Discover the power rule, a handy tool for finding the derivative of x^n . (4 min)

Power Rule (With Rewriting the Expression)

Discover how the power rule helps us find derivatives of functions like $1/x$, $\sqrt[3]{x}$, or $\sqrt[3]{x^2}$. (5 min)

Basic Derivative Rules

Explore how to find the derivative of any polynomial using the power rule and additional properties. (10 min)

Basic Derivative Rules: Find the Error

Analyze two students' attempts to differentiate linear functions using basic rules. (5 min)

Basic Derivative Rules: Table

Explore a problem involving two functions, f and g , and their derivatives at specific points. (9 min)

Differentiating Polynomials

Explore how to differentiate polynomials using the power rule and derivative properties. (7 min)

Differentiating Integer Powers (Mixed Positive and Negative)

Explore how to differentiate the function $g(x) = 2/(x^3) - 1/(x^2)$ and evaluate the derivative at $x = 2$. (5 min)

Tangents of Polynomials

Find the equation of the line tangent to the graph of $f(x) = x^3 - 6x^2 + x - 5$ at $x = 1$. (5 min)

Differentiation | Derivatives of $\cos(x)$, $\sin(x)$, e^x , & $\ln(x)$

Derivatives of $\sin(x)$ and $\cos(x)$

Explore the intuition behind the derivatives of trigonometric functions, discovering that the derivative of $\sin(x)$ is $\cos(x)$ and the derivative of $\cos(x)$ is $-\sin(x)$. (4 min)

Worked Example: Derivatives of $\sin(x)$ and $\cos(x)$

Discover the derivative of the function $g(x) = 7\sin(x) - 3\cos(x) - (\pi/\sqrt[3]{x})^2$. (5 min)

Derivative of e^x

Explore the properties of the derivative of e^x . (3 min)

Derivative of $\ln(x)$

Discover the derivative of $\ln(x)$ is $1/x$. (2 min)

Differentiation | Product Rule & Quotient Rule

Product Rule

Discover the product rule, a fundamental technique for finding the derivative of a function expressed as a product of two functions. (3 min)

Differentiating Products

Explore the product rule by finding the derivative of $e^x \cos(x)$. (4 min)

Worked Example: Product Rule with Table

Explore how to evaluate the derivative of the product of two functions, $f(x)$ and $h(x)$, at $x=3$, using given values for f , h , and their derivatives. (3 min)

Worked Example: Product Rule with Mixed Implicit & Explicit

Explore how to calculate the derivative of $F(x) = f(x) \cdot g(x)$ at $x = -1$, given the values of f and f' at $x = -1$ and $g(x) = 1/x$. (3 min)

Quotient Rule

Discover the quotient rule, a powerful technique for finding the derivative of a function expressed as a quotient. (4 min)

Worked Example: Quotient Rule with Table

Explore how to find the derivative of $F(x) = f(x)/g(x)$ at $x = -1$, given the values of f and f' at $x = -1$ and $g(x) = 2x^3$. (6 min)

Differentiating Rational Functions

Discover the differentiation of the rational function $(5-3x)/(x^2+3x)$ using the Quotient Rule. (7 min)

Derivatives of $\tan(x)$ and $\cot(x)$

Find the derivatives of $\tan(x)$ and $\cot(x)$ by rewriting them as quotients of $\sin(x)$ and $\cos(x)$. (5 min)

Derivatives of $\sec(x)$ and $\csc(x)$

Explore the derivatives of $\sec(x)$ and $\csc(x)$ by expressing them as $1/\cos(x)$ and $1/\sin(x)$, respectively, and applying the quotient rule. (4 min)

Differentiation | Intro to the Chain Rule

Chain Rule

Discover that the chain rule states that the derivative of $f(g(x))$ is $f'(g(x)) \cdot g'(x)$. (5 min)

Common Chain Rule Misunderstandings

Explore these three common student misconceptions when applying the chain rule. (7 min)

Identifying Composite Functions

Review of composite functions and how to recognize them. (8 min)

Worked Example: Derivative of $\cos^3(x)$

Using the Chain Rule

Examine this example of composite functions, using the example $f(x) = \cos^3(x)$. (9 min)

Worked Example: Derivative of $\sqrt{(3x^2-x)}$

Using the Chain Rule

Discover the process of differentiating a composite function, specifically

$f(x) = \sqrt{3x^2 - x}$, using the chain rule.

(6 min)

Worked Example: Derivative of $\ln(\sqrt{x})$

Using the Chain Rule

Examine and dissect the composite function $f(x) = \ln(\sqrt{x})$ into its parts, $\ln(x)$ and \sqrt{x} .

(7 min)

Differentiation | The Chain Rule: More Practice

Worked Example: Chain Rule with Table

Explore the Chain rule with a table. (3 min)

Derivative of a^x (For Any Positive Base a)

Explore the derivative of a^x for any positive base a . (6 min)

Derivative of $\log_a x$ (For Any Positive Base $a \neq 1$)

Find the derivative of $\log_a x$ for any positive base $a \neq 1$. (5 min)

Worked Example: Derivative of $7^{(x^2-x)}$

Using the Chain Rule

Explore the process of differentiating the exponential function $7^{(x^2-x)}$. (4 min)

Worked Example: Derivative of $\log_4(x^2+x)$

Using the Chain Rule

Explore a worked example of differentiating the logarithmic function $\log_4(x^2+x)$ using the chain rule. (4 min)

Worked Example: Derivative of $\sec(3\pi/2-x)$ Using the Chain Rule

Explore the process of differentiating the function $\sec(3\pi/2-x)$ in this worked example. (7 min)

Worked example: Derivative of $\sqrt[4]{(x^3+4x^2+7)}$ Using the Chain Rule

Explore the challenge of differentiating the fourth root of a polynomial expression in this worked example. (6 min)

Differentiation | Implicit Differentiation

Implicit Differentiation

Explore how Implicit differentiation helps us find dy/dx even for relationships like that.

(8 min)

Worked Example: Implicit Differentiation

Use implicit differentiation to solve the equation $(x-y)^2 = x + y - 1$ in this worked example. (5 min)

Worked Example: Evaluating

Derivative with Implicit Differentiation

Calculate the slope of a tangent line at a specific point on a curve using implicit differentiation. (5 min)

Showing Explicit and Implicit

Differentiation Gives Same Result

Discover the connection between implicit and explicit differentiation. (8 min)

Differentiation | Differentiating Inverse Functions

Derivatives of Inverse Functions

Learn that Functions f and g are inverses if $f(g(x)) = x = g(f(x))$ and see how it applies to e^x and $\ln(x)$. (5 min)

Derivatives of Inverse Functions:

From Equation

Explore the relationship between a function and its inverse, focusing on the function

$f(x) = \frac{1}{2}x^3 + 3x - 4$. (5 min)

Derivatives of Inverse Functions:

From Table

Discover inverse functions, exploring how to evaluate the derivative of an inverse function, h' , at a specific x -value. (5 min)

Derivative of Inverse Sine

Learn to find the derivative of inverse sine. (5 min)

Derivative of Inverse Cosine

Learn to find the inverse cosine function. (4 min)

Derivative of Inverse Tangent

Learn to find the derivative of the inverse tangent function. (6 min)

Differentiation | Strategies for Calculating Derivatives

Differentiating Functions: Find the Error

Examine the work of students differentiating various functions to see if they made a mistake, and if so, what mistake. (11 min)

Manipulating Functions Before Differentiation

Explore how to rewrite a function before differentiating it so the process of differentiation is faster and easier. (11 min)

Differentiating Using Multiple Rules: Strategy

Analyze the structure of an elaborate expression to determine which derivative rules to use, and (not less important) in what order. (6 min)

Applying the Chain Rule and Product Rule

Explore this example showing multiple strategies for taking a derivative that involves both the product rule and the chain rule. (6 min)

Applying the Chain Rule Twice

Solve this example applying the chain rule twice. (3 min)

Derivative of $e^{\cos x} \cdot \cos(e^x)$

Differentiate $e^{\cos x} \cdot \cos(e^x)$ by applying both the product rule and the chain rule. (6 min)

Derivative of $\sin(\ln(x^2))$

Differentiate $\sin(\ln(x^2))$ by applying the chain rule twice. (5 min)

Disguised Derivatives

Differentiates the product of three different functions and generalizes for the derivative of the product of any number of functions. (5 min)

Differentiation | Higher-Order Derivatives

Second Derivatives

Find the second derivative of $y=6/x^2$. Second derivative is the derivative of the derivative of y . (3 min)

Second Derivatives (Implicit Equations): Find Expression

Given an implicit equation in x and y , find the expression for the second derivative of y with respect to x . (5 min)

Second Derivatives (Implicit Equations): Evaluate Derivative

Given the first derivative of an implicit equation in x and y , evaluate the second derivative at a certain point. (5 min)

Differentiation | Proofs of Derivative Rules

Proof: Differentiability Implies Continuity

Discover that if a function is differentiable at a point, it is also continuous at that point. (12 min)

Justifying the Power Rule

Explore the power rule's validity by examining the derivatives of x^1 and x^2 . (7 min)

Proof of Power Rule for Positive Integer Powers

Explore the formula for the derivative of x^n by skillfully applying the binomial theorem. (7 min)

Proof of Power Rule for Square Root Function

Explore a proof of the power rule for the special case when $n=1/2$, focusing on the derivative of \sqrt{x} . (5 min)

Limit of $\sin(x)/x$ as x Approaches 0

Prove that the limit of $\sin(\theta)/\theta$ as θ approaches 0 is equal to 1. (9 min)

Limit of $(1-\cos(x))/x$ as x Approaches 0

Explore the limit of $(1-\cos(x))/x$ as x approaches 0 and show that it equals 0. (4 min)

Proof of the Derivative of $\sin(x)$

Discover the proof that the derivative of $\sin(x)$ equals $\cos(x)$. (6 min)

Proof of the Derivative of $\cos(x)$

Examine that the derivative of $\sin(x)$ equals $\cos(x)$ to visually demonstrate that the derivative of $\cos(x)$ equals $-\sin(x)$. (4 min)

Product Rule Proof

Explore the proof of the product rule, a key concept in calculus. (9 min)

If Function u is Continuous at x , Then $\Delta u \rightarrow 0$ as $\Delta x \rightarrow 0$

Discover that if a function is continuous, the difference in the function's values approaches 0 as the difference in the x -values approaches 0. (7 min)

Chain Rule Proof

Use the formal properties of continuity and differentiability to see why the chain rule is true. (6 min)

Quotient Rule from Product & Chain Rules

Explore how you can derive the quotient rule using the product rule and the chain rule. (5 min)

Differentiation | Straight-Line Motion: Connecting Position, Velocity, & Acceleration

Introduction to One-Dimensional Motion with Calculus

Discover that straight-line motion can be modeled by giving position as a function of time. (7 min)

Interpreting Direction of Motion from Position-Time Graph

Given the position-time graph of a linear motion, interpret whether the moving object moves forward or backward. (3 min)

Interpreting Direction of Motion from Velocity-Time Graph

Given the velocity-time graph of a linear motion, interpreting whether the moving object moves forward or backward. (2 min)

Interpreting Change in Speed from Velocity-Time Graph

Explore this example thinking about speed from velocity-time graph. (4 min)

Worked Example: Motion Problems with Derivatives

Find and interpret the velocity and acceleration given position as a function of time. (5 min)

Differentiation | Rates of Change in Other Applied Contexts

Interpreting the Meaning of the Derivative in Context

Discover how to make sense of derivatives when they are used to describe real-world situations. (5 min)

Applied Rate of Change: Forgetfulness

Explore applied rate of change in this problem about forgetfulness. (5 min)

Marginal Cost & Differential Calculus

In economics, the idea of marginal cost can be nicely captured with the derivative. (5 min)

Differentiation | Related Rates

Related Rates Intro

Examine the relationship between how fast a circle's radius changes, and how fast its area changes. (8 min)

Analyzing Related Rates Problems: Expressions

Explore and understand all the involved quantities in a related rates problem. (8 min)

Analyzing Related Rates Problems: Equations (Pythagoras)

Discover that a crucial part of solving related rates problems is picking an equation that correctly relates the quantities. (4 min)

Analyzing Related Rates Problems: Equations (Trig)

Find the rate of change of an angle that a falling ladder forms with the ground. (8 min)

Differentiating Related Functions Intro

Use the chain rule, find the derivatives of those functions with respect to that variable. (4 min)

Worked Example: Differentiating Related Functions

Learn how to use implicit differentiation to find the derivatives of the functions with respect to that variable. (8 min)

Related Rates: Approaching Cars

Explore how the rate of change of the distance between them changes as two cars approach the same intersection from different roads. (7 min)

Related Rates: Falling Ladder

Discover the rate of change in this problem. (6 min)

Related Rates: Water Pouring into a Cone

As you pour water into a cone, discover how the rate of change of the depth of the water relate to the rate of change in volume. (12 min)

Related Rates: Shadow

Solve a related rates problem about the shadow an owl casts as it's hunting a mouse. (11 min)

Related Rates: Balloon

Analyze the rate of change of a balloon's altitude based on the angle you must crane your neck to look at it. (8 min)

Differentiation | Local Linearity

Local Linearity

Explore the idea of approximating curves using their tangent line equations. (10 min)

Local Linearity and Differentiability

Learn how local linearity relates to differentiability using the Desmos graphing calculator. (7 min)

Worked Example: Approximation with Local Linearity

Find the equation of a tangent line at a point of a curve by knowing the derivative at that point. (4 min)

Linear Approximation of a Rational Function

Find a linear expression that approximates $y=1/(x-1)$ around $x=-1$. (7 min)

Differentiation | L'Hôpital's Rule: Limits of Indeterminate Forms

L'Hôpital's Rule Introduction

When you are solving a limit, and get $0/0$ or ∞/∞ , L'Hôpital's rule is the tool you need. (9 min)

L'Hôpital's Rule: Limit at 0 Example

Use L'Hôpital's rule to find the limit at 0 of $(2\sin(x) - \sin(2x))/(x - \sin(x))$. (8 min)

L'Hôpital's Rule: Limit at Infinity Example

Use L'Hôpital's rule to find the limit at infinity of $(4x^2 - 5x)/(1 - 3x^2)$. (5 min)

Differentiation | Using the Mean Value Theorem

Mean Value Theorem

The Mean Value Theorem states that if a function f is continuous on the closed interval $[a, b]$ and differentiable on the open interval (a, b) , then there exists a point c in the interval (a, b) such that $f'(c)$ is equal to the function's average rate of change over $[a, b]$. (7 min)

Mean Value Theorem Example: Polynomial

Find the number that satisfies the Mean value theorem for $f(x) = x^2 - 6x + 8$ over the interval $[2, 5]$. (5 min)

Mean Value Theorem Example: Square Root Function

Find the number that satisfies the Mean value theorem for $f(x) = \sqrt{4x - 3}$ over the interval $[1, 3]$. (7 min)

Justification with the Mean Value Theorem: Table

Explore this example justifying use of mean value theorem (where function is defined with a table). (4 min)

Justification with the Mean Value Theorem: Equation

Explore this example justifying use of mean value theorem (where function is defined with an equation). (3 min)

Mean Value Theorem Application

Explore how to apply the mean value theorem in this speeding problem. (7 min)

Differentiation | Extrema, Critical Points, & Intervals

Extreme Value Theorem

The extreme value theorem states that if a function is continuous on a closed interval $[a, b]$, then the function must have a maximum and a minimum on the interval. (8 min)

Critical Points Introduction

Discover the "critical points" of a function and discuss their relationship with the extremum points of the function. (8 min)

Finding Critical Points

Find the critical points of $f(x) = xe^{-2x^2}$. (6 min)

Finding Decreasing Interval Given the Function

Find the intervals where the function $f(x) = x^6 - 3x^5$ is decreasing by analyzing the intervals where f' is positive or negative. (5 min)

Finding Increasing Interval Given the Derivative

Given that the derivative of function g , is $g'(x) = x^2/(x-2)^3$, find the intervals where g is increasing, by looking for the intervals where g' is positive. (6 min)

Introduction to Minimum and Maximum Points

Discover all about minimum and maximum points, both absolute and relative. (6 min)

Finding Relative Extrema (First Derivative Test)

Discover how to find a critical point and tell if it is a minimum, maximum or neither. (5 min)

Worked Example: Finding Relative Extrema

Find the relative maximum point of $g(x) = x^4 - x^5$ by analyzing the intervals where its derivative, g' , is negative or positive. (8 min)

Analyzing Mistakes when Finding Extrema (Example 1)

Examine the work of someone who tried to find extrema of a function, to see whether they made mistakes. (5 min)

Analyzing Mistakes when Finding Extrema (Example 2)

Examine the work of someone who tried to find extrema of a function, to see whether they made mistakes. (5 min)

Finding Absolute Extrema on a Closed Interval

Find the absolute maximum value of $f(x) = 8\ln(x) - x^2$ over the interval $[1, 4]$. (7 min)

Absolute Minima & Maxima (Entire Domain)

Discover the absolute minimum and maximum points of $g(x) = x^2\ln(x)$ over its entire domain. (10 min)

Second Derivative Test

Explore an example of the second derivative test, which is a way of determining relative minima & maxima. (6 min)

Differentiation | Concavity & Points of Inflection

Concavity Introduction

Explore the concept of concavity, what it means for a graph to be "concave up" or "concave down," and how this relates to the second derivative of a function. (10 min)

Analyzing Concavity (Graphical)

Solve an exercise where you are asked to recognize the concavity of a function in certain regions. (3 min)

Inflection Points Introduction

Discover that Inflection points are points where the function changes concavity, i.e. from being "concave up" to being "concave down" or vice versa. (3 min)

Inflection Points (Graphical)

Analyze the graph of a function g to find all the inflection points of g . (4 min)

Analyzing Concavity (Algebraic)

Find the intervals where $g(x) = -x^4 + 6x^2 - 2x - 3$ is concave down/up by finding where its second derivative, g'' , is positive/negative. (9 min)

Inflection Points (Algebraic)

Analyze the points of inflection of $g(x) = \frac{1}{4}x^4 - 4x^3 + 24x^2$ by looking for values where the second derivative g'' changes signs. (6 min)

Mistakes When Finding Inflection Points: Second Derivative Undefined

Candidates for inflection points are points where the second derivative is zero *and* points where the second derivative is undefined. (6 min)

Mistakes When Finding Inflection Points: Not Checking Candidates

Explore how to test x -values and see if they really are inflection points. (4 min)

Horizontal Tangent to Implicit Curve

Find the equation of a horizontal tangent to a curve that is defined implicitly as an equation in x and y . (3 min)

Differentiation | Sketching Curves of Functions & Their Derivatives

Curve Sketching with Calculus: Polynomial

Visualize a graph of $f(x) = 3x^4 - 4x^3 + 2$ including extremum and inflection points. (20 min)

Curve Sketching with Calculus: Logarithm

Visualize a graph of $f(x) = \ln(x^4 + 27)$ including extremum and inflection points. (25 min)

Analyzing a Function with its Derivative

Taking the derivative of $f(x) = x^3 - 12x + 2$ and graphing the derivative, find when f is increasing or decreasing, and where is its relative extremum points. (10 min)

Differentiation | Connecting a Function, Its First Derivative, & Its Second Derivative

Calculus-Based Justification for Function Increasing

Discover that a calculus-based justification is when we explain a property of a function f based on its derivative f' . (4 min)

Justification Using First Derivative

Explore why a function is increasing, decreasing, or having a relative maximum using information about its first derivative. This is called calculus-based justification. (6 min)

Inflection Points from Graphs of Function & Derivatives

Identify inflection points from graphs of function, first derivative and second derivative. (5 min)

Justification Using Second Derivative: Inflection Point

Justify whether a function has an inflection point by looking at where the second derivative changes its sign. (4 min)

Justification Using Second Derivative: Maximum Point

Given that the derivative of a function is zero, justify whether the function has a relative maximum point by looking at the second derivative. (4 min)

Connecting f , f' , and f'' Graphically (Example 1)

Examine three graphs to see which describes the derivative of which another graph. (6 min)

Connecting f , f' , and f'' Graphically (Example 2)

Examine three graphs to see which describes the derivative of which another graph. (4 min)

Differentiation | Solving Optimization Problems

Optimization: Sum of Squares

Discover what the minimum possible value of $x^2 + y^2$ is given that their product must be fixed at $xy = -16$. (8 min)

Optimization: Box Volume (Part 1)

Explore how to maximize the volume in this box problem. (10 min)

Optimization: Box Volume (Part 2)

Examine the formulas needed to solve this box problem. (9 min)

Optimization: Profit

Explore how to maximize profits in this optimization problem about a shoe factory. (12 min)

Optimization: Cost of Materials

Explore optimization as you figure out how to minimize the cost of storage. (13 min)

Optimization: Area of Triangle & Square (Part 1)

Construct an equilateral triangle & a square whose bases are 100m (about 328.08 ft) together, such that their area is the smallest possible. (6 min)

Optimization: Area of Triangle & Square (Part 2)

Construct an equilateral triangle & a square whose bases are 100m (about 328.08 ft) together, such that their area is the smallest possible. (5 min)

Motion Problems: Finding the Maximum Acceleration

The speed of a particle moving along the x-axis is given by $v(t) = -t^3 + 6t^2 + 2t$, find the time when the particle's acceleration attains its maximum value. (4 min)

Integration | Intro to Integrals: Accumulation of Change

Introduction to Integral Calculus

Discover that the basic idea of Integral calculus is finding the area under a curve. (4 min)

Definite Integrals Intro

Explore that Definite integrals represent the area under the curve of a function and above the x-axis. (8 min)

Worked Example: Accumulation of Change

Examine this example relating rates of change with a leaky bathtub. (7 min)

Integration | Riemann Sums

Riemann Approximation Introduction

Discover how Riemann sum approximates the area under a curve using some rectangles. (7 min)

Over- and Under-Estimation of Riemann Sums

Explore the difference between overestimation and underestimation when using Riemann sums. (4 min)

Worked Example: Finding a Riemann Sum Using a Table

Given a table of values of a function, use it to find a Riemann sum approximation of that function. (7 min)

Worked Example: Over- and Under-Estimation of Riemann Sums

Examine how to order different areas from least to greatest. (5 min)

Midpoint Sums

Explore approximating area under a curve using rectangle where the heights are the value of the function at the midpoint of each interval. (6 min)

Trapezoidal Sums

Discover that the area under a curve is commonly approximated using rectangles (e.g. left, right, and midpoint Riemann sums), but it can also be approximated by trapezoids. (9 min)

Summation Notation

Learn how to use Sigma, Σ , which is the standard notation for writing long sums. (5 min)

Worked Examples: Summation Notation

Explore examples of how we read expressions in summation notation. (6 min)

Riemann Sums in Summation Notation

Generalize the technique of approximating area under a curve with rectangles. (9 min)

Worked example: Riemann Sums in Summation Notation

Express the approximation of the area under a curve in sigma notation. (7 min)

Definite Integral as the Limit of a Riemann Sum

Learn to use Riemann sums with infinite rectangles of infinitely small width (using limits), we get the exact area, i.e. the definite integral. (5 min)

Worked Example: Rewriting Definite Integral as Limit of Riemann Sum

Given a definite integral expression, write the corresponding limit of a Riemann sum with infinite rectangles. (6 min)

Worked Example: Rewriting Limit of Riemann Sum as Definite Integral

Given a limit of Riemann sum with infinite rectangles, analyze the expression to find the corresponding definite integral. (7 min)

Integration | The Fundamental Theorem of Calculus: Accumulation Functions

The Fundamental Theorem of Calculus and Accumulation Functions

Explore how the fundamental theorem of calculus shows how, in some sense, integration is the opposite of differentiation. (8 min)

Functions Defined by Definite Integrals (Accumulation Functions)

Discover that a function can be defined using a definite integral. (4 min)

Finding Derivative with Fundamental Theorem of Calculus: Chain Rule

Explore how to incorporate the chain rule into the fundamental theorem of calculus. (3 min)

Interpreting the Behavior of Accumulation Functions

Given the graph of function f , reason about the graph of its antiderivative g (so $g'=f$). (9 min)

Proof of Fundamental Theorem of Calculus

Explore the fundamental theorem of calculus and learn that if we define $F(x)$ to be the definite integral of function f from some constant a to x , then F is an antiderivative of f . (14 min)

Intuition for Second Part of Fundamental Theorem of Calculus

Explore that the second part of the fundamental theorem of calculus tells us that to find the definite integral of a function f from a to b , we need to take an antiderivative of f , call it F , and calculate $F(b)-F(a)$. (13 min)

Integration | Applying Properties of Definite Integrals

Negative Definite Integrals

Learn that definite integrals give us the area under the curve and above the x-axis. (5 min)

Finding Definite Integrals Using Area Formulas

Discover that definite integrals are the net area between a curve and the x-axis, we can sometimes use geometric area formulas to find definite integrals. (4 min)

Definite Integral Over a Single Point

Discover what happens when the bounds of your integral are the same. (3 min)

Integrating Scaled Version of Function

Use a graph to explain why we can take a constant out of a definite integral. (5 min)

Switching Bounds of Definite Integral

Discover what happens when you swap the bounds on an integral. (5 min)

Integrating Sums of Functions

Given the integrals of two functions, find the integral of their sum. (7 min)

Worked Examples: Finding Definite Integrals Using Algebraic Properties

Evaluate definite integrals of functions given their graphs. (3 min)

Definite Integrals on Adjacent Intervals

Learn how to break up an integral by subdividing the stretch of numbers where you are integrating. (3 min)

Worked Example: Breaking up the Integral's Interval

Find a definite integral by breaking it down to smaller intervals that are adjacent to each other. (7 min)

Worked Example: Merging Definite Integrals Over Adjacent Intervals

Discover how to evaluate the sum of definite integrals over adjacent intervals. (4 min)

Functions Defined by Integrals: Switched Interval

Evaluate a function defined by the integral of a graphed function. (3 min)

Finding Derivative with Fundamental Theorem of Calculus:

X is on Lower Bound

Discover how to swap the bounds of integration before applying the fundamental theorem of calculus. (3 min)

Finding Derivative with Fundamental Theorem of Calculus: X is on Both Bounds

Explore how to apply the fundamental theorem of calculus when both integral bounds are a function of x . (5 min)

The Fundamental Theorem of Calculus and Definite Integrals

Explore the two versions of the fundamental theorem of calculus, and the connection between them. (5 min)

Antiderivatives and Indefinite Integrals

Explore what the "indefinite integral" is and how it is the opposite of a derivative. (4 min)

Integration | Indefinite Integrals: Basic Rules & Notation

Reverse Power Rule

Find a function whose derivative is x^n . (6 min)

Indefinite Integrals: Sums & Multiples

Discover that an indefinite integral of a sum is the same as the sum of the integrals of the component parts. (5 min)

Rewriting Before Integrating

Explore how some indefinite integrals are much simpler to integrate by algebraically rewriting the integrand first. (5 min)

Indefinite Integral of $1/x$

Explore how Integration goes the other way: the integral (or antiderivative) of $1/x$ should be a function whose derivative is $1/x$. As we just saw, this is $\ln(x)$. However, if x is negative then $\ln(x)$ is undefined. (8 min)

Indefinite Integrals of $\sin(x)$, $\cos(x)$, and e^x

Learn why $\int \sin(x)dx = -\cos(x) + C$, $\int \cos(x)dx = \sin(x) + C$, and $\int e^x dx = e^x + C$. (4 min)

Integration | Definite Integrals: Basic Rules & Notation

Definite Integrals: Reverse Power Rule

Explore examples of calculating definite integrals of polynomials using the fundamental theorem of calculus and the reverse power rule. (4 min)

Definite Integral of Rational Function

Find the definite integral of $(16-x^3)/x^3$ between -1 and -2 using the reverse power rule. (5 min)

Definite Integral of Radical Function

Find the definite integral of $12\sqrt[3]{x}$ between -1 and 8 using the reverse power rule. (4 min)

Definite Integral of Trig Function

Find the definite integral of $9\sin(x)$ between $11\pi/2$ and 6π . (5 min)

Definite Integral Involving Natural Log

Find the definite integral of $(6+x^2)/x^3$ between 2 and 4. (8 min)

Definite Integral of Piecewise Function

Evaluate definite integral of a piecewise function over an interval that goes through the two cases of the function. (7 min)

Definite Integral of Absolute Value Function

Evaluate the definite integral of $f(x)=|x+2|$ between -4 and 0. (7 min)

Integration | Integrating Using Substitution

u -Substitution Intro

Discover how to use u -substitution to find the anti-derivative of a function. (5 min)

u -Substitution: Multiplying by a Constant

Learn how to manipulate the expression to make u -substitution a little more obvious. (6 min)

u -Substitution: Defining u

Examine a common challenge when performing u -substitution is to realize which part should be our u . (4 min)

u -Substitution: Defining u (More Examples)

Examine a common challenge when performing u -substitution is to realize which part should be our u . (5 min)

u -Substitution: Rational Function

Work through another example of using u -substitution. (4 min)

u -Substitution: Logarithmic Function

Explore doing u -substitution with $\ln(x)$. (4 min)

u -Substitution: Definite Integrals

Discover that when using u -substitution in definite integrals, we must make sure we take care of the boundaries of integration. (6 min)

u -Substitution: Definite Integral of Exponential Function

Find the definite integral from 0 to 1 of $x^2 \cdot 2^{(x^3)}$. (8 min)

Integration | Other Methods of Integration

Revisiting Polynomial Long Division

Learn how to divide polynomials, also known as algebraic long division. (12 min)

Integration Using Long Division

Explore how to do polynomial long division to make an integral more computable. (5 min)

Integration Using Completing the Square and the Derivative of $\arctan(x)$

Discover how to integrate rational functions by using the method of completing the square in the denominator and then integrating using u -substitution and our knowledge about the derivative of $\arctan(x)$. (6 min)

Integration | Average Value of a Function on an Interval

Average Value Over a Closed Interval

Discover the average value of a function over a closed interval. (5 min)

Calculating Average Value of Function Over Interval

Find the average value of x^2+1 on the interval between 0 and 3. (5 min)

Mean Value Theorem for Integrals

Discover the connection between the mean value theorem and integration. (9 min)

Integration | Connecting Position, Velocity, & Acceleration Using Integrals

Motion Problems with Integrals: Displacement vs. Distance

Discover how the definite integral of a velocity function gives us the displacement. (8 min)

Analyzing Motion Problems: Position

Find the appropriate expression to use when looking for the position at a certain time. (3 min)

Analyzing Motion Problems: Total Distance Traveled

Find the appropriate expression to use when looking for the total distance traveled over a certain time interval. (3 min)

Worked Example: Motion Problems (With Definite Integrals)

Discover the velocity and position of a particle given its acceleration. (9 min)

Average Acceleration Over Interval

Explore an example of finding a mean value, we find an average acceleration. (5 min)

Integration | Accumulation Functions & Definite Integrals in Context

Area Under Rate Function Gives the Net Change

When given a function representing rate, explore what the area under its curve represents. (8 min)

Interpreting Definite Integrals as Net Change Explore how to interpret definite integrals in a real-world context. (5 min)

Worked Examples: Interpreting Definite Integrals in Context

Explore how to interpret expressions involving definite integrals in a real-world context. (4 min)

Analyzing Problems Involving Definite Integrals

Explore example of how to find the appropriate expression to use to solve word problems using definite integrals. (6 min)

Worked Example: Problem Involving Definite Integral (Algebraic)

Use definite integral to solve a word problem about the growth in the population of a town. (8 min)

Integration | Finding the Area Between Curves

Area Between a Curve and the X-Axis

Based on the fundamental theorem of calculus, use antiderivatives to compute integrals. (6 min)

Area Between a Curve and the X-Axis: Negative Area

Explore the idea of introducing the notion of "negative area" with integrals. (8 min)

Area Between Curves

Explore how to integrate the difference of two functions to find the area between them. (7 min)

Composite Area Between Curves

Discover how to break the area into multiple different areas because the enclosing functions change. (7 min)

Area Between a Curve and the Y-Axis

Use a definite integral in terms of y to find the area between a curve and the y -axis. (4 min)

Horizontal Area Between Curves

Use a definite integral in terms of y to find the horizontal area between curves of two functions of y . (8 min)

Integration | Volume with Cross Sections

Volume with Cross Sections: Intro

Use definite integration to find volume of a solid whose base is given as a region between function and whose cross sections are squares. (6 min)

Volume with Cross Sections: Squares and Rectangles (No Graph)

Learn to express the volume of a 3-D figure as a definite integral (where the area of cross sections are functions of x). (6 min)

Volume with Cross Sections Perpendicular to Y-Axis

Explore this example expressing the volume of a figure based on cross sections perpendicular to the y -axis as a definite integral (integrating with respect to y). (5 min)

Volume with Cross Sections: Semicircle

Discover the volume of a solid with semi-circular cross sections and a triangular base. (9 min)

Volume with Cross Sections: Triangle

Explore the cross section of our solid is given as the area between two curves. (9 min)

Integration | Volume with the Disc Method

Disc Method Around X-Axis

Find the solid of revolution (constructed by revolving around the x-axis) using the disc method. (9 min)

Generalizing Disc Method Around X-Axis

Generalize $f(x)$ to get the "formula" for using the disc method around the x-axis. (3 min)

Disc Method Around Y-Axis

Find the volume of a figure that is rotated around the y-axis using the disc method. (8 min)

Disc Method Rotation Around Horizontal Line

Explore volume of the solid of revolution constructed by rotating around a line that is not an axis. (10 min)

Disc Method Rotating Around Vertical Line

Discover the Volume of solid created by rotating around vertical line that is not the y-axis using the disc method. (5 min)

Calculating Integral Disc Around Vertical Line

Calculate the integral from around the vertical line. (6 min)

Integration | Volume with the Washer Method

Solid of Revolution Between Two Functions (Leading Up to the Washer Method)

Find the volume of a solid of revolution that is defined between two functions. (9 min)

Generalizing the Washer Method

Explore this example of generalizing the washer method. (9 min)

Washer Method Rotating Around Horizontal Line (Not X-Axis), Part 1

Discover the Washer method when rotating around a horizontal line that is not the x-axis. (7 min)

Washer Method Rotating Around Horizontal Line (Not X-Axis), Part 2

Evaluate the definite integral from the of the washer method. (8 min)

Washer Method Rotating Around Vertical Line (Not Y-Axis), Part 1

Set up the definite integral for the volume of a solid of revolution around a vertical line using the "washer" or "ring" method. (8 min)

Washer Method Rotating Around Vertical Line (Not Y-Axis), Part 2

Evaluate the integral set up in the last video using washer method. (6 min)

Differential Equations | Intro to Differential Equations

Differential Equations Introduction

Discover that Differential equations are equations that relate a function with one or more of its derivative. (8 min)

Writing a Differential Equation

Explore how differential equations describe relationships that involve quantities and their rates of change. (3 min)

Verifying Solutions to Differential Equations

Explore how to check whether a potential solution to a differential equation is indeed a solution. (6 min)

Differential Equations | Intro to Slope Fields

Slope Fields Introduction

Learn how to draw and use slope fields, which allows us to analyze differential equations graphically. (6 min)

Worked Example: Equation from Slope Field

Given a slope field and a few differential equations, determine which equation corresponds to the slope field by considering specific slopes. (6 min)

Worked Example: Slope Field from Equation

Given a differential equation in x and y , draw a segment with dy/dx as slope at any point (x,y) . (4 min)

Worked Example: Forming a Slope Field

Given a differential equation in x and y , draw a segment with dy/dx as slope at any point (x,y) . (4 min)

Approximating Solution Curves in Slope Fields

Given the slope field of a differential equation, sketch various solutions to the equation. (7 min)

Worked Example: Range of Solution Curve from Slope Field

Given the slope field of a differential equation, sketch various solutions to the equation. (3 min)

Differential Equations | Separation of Variables

Separable Equations Introduction

Explore how "separation of variables" allows us to rewrite differential equations so we obtain an equality between two integrals we can evaluate. (9 min)

Addressing Treating Differentials Algebraically

Explore how to address treating differentials algebraically. (5 min)

Worked Example: Separable Differential Equations

Explore these two worked examples of finding general solutions to separable differential equations. (4 min)

Worked Example: Identifying Separable Equations

Analyze various differential equations to see if they are separable. (5 min)

Particular Solutions to Differential Equations: Rational Function

Find $f(-1)$ given that $f'(x)=24/x^3$ and $f(2)=12$. (5 min)

Particular Solutions to Differential Equations: Exponential Function

Find $f(0)$ given that $f'(x)=5e^x$ and $f(7)=40+5e^7$. (4 min)

Worked Example: Finding a Specific Solution to a Separable Equation

Solve a separable differential equation given initial conditions. (6 min)

Worked Example: Separable Equation with an Implicit Solution

Discover that sometimes the solution of a separable differential equation can't be written as an explicit function. (4 min)

Differential Equations | Exponential Models with Differential Equations

Exponential Models & Differential Equations (Part 1)

Assuming a quantity grows proportionally to its size results in the general equation $dy/dx=ky$, solve it with separation of variables results in the general exponential function $y=Ce^{kx}$. (8 min)

Exponential Models & Differential Equations (Part 2)

Given the general solution $P=Ce^{kt}$ and the conditions $P(0)=100$ and $P(50)=200$, find the solution to an exponential modeling problem. (5 min)

Worked Example: Exponential Solution to Differential Equation

Examine the solution of the general differential equation $dy/dx=ky$ (for some k) is $C \cdot e^{kx}$ (for some C). (4 min)

INTERACTABLE OBJECTS

- **US Bills:** \$1 | \$2 | \$5 | \$10 | \$20 | \$50 | \$100
- **US Coins:** Penny | Nickel | Dime | Quarter
- **Money Pallets:** \$100m | \$10m | \$1m
- **Money Stacks:** \$100k | \$10k | \$1k
- **10 × 10 Array:** Interactive math tool used to help students understand fractions, decimals, percents, and ratios by toggling 100 individual cubes on or off.
- **Multiplication Table:** An interactive 10x10 multiplication table that visualizes multiplication in rows and columns. Individual numbers can be toggled on or off to allow for quizzing.
- **Tens Frame:** Students can use the interactive Tens Frame to explore the concepts of basic addition, subtraction, and representation of numbers 1-10.
- **Number Builder:** This interactive math tool lets students explore place values up to the trillions place, and down to the trillionths place. The value of each place can be set, allowing users to create any number, big or small. Teachers can also use this as a quizzing tool by hiding the place value labels.
- **Number Line - Whole Numbers (Positive):** This interactive math tool shows whole numbers 1-100, grouped in sections of 10 at a time. Students can use this tool to practice counting by 1, 2, 3, 4, 5, or 10.
- **Place Value Blocks:** Students can learn about place value with these 3D blocks representing 1, 10, 100, and 1000.
- **Place Value Whiteboard:** This interactive whiteboard is labeled with boxes to represent the place value of numbers. Students can use this as a tool to learn about place value, then compare the values of two different numbers.
- **Point Plotter:** Plot up to 12 line segments on a grid by defining each point's position and rotation.
- **Abacus:** Interactive math tool lets students toggle individual beads back and forth, which they can use to learn about place value, perform basic calculations, or represent large numbers.
- **Scalable Objects:** Cone | Cube | Cylinder | Sphere | Triangular Prism | Rectangular Pyramid | Triangular Pyramid | Rhombus Tile | Narrow Rhombus Tile | Wide Rhombus Tile | Pentagon Tile | Octagon Tile | Hexagon Tile | Trapezoid Tile | Square Tile | Obtuse Isosceles Triangle Tile | Acute Isosceles Triangle Tile | Equilateral Triangle Tile
- **Exponents Visualizer:** A visualization of how exponents work using colorful cubes for numbers 1-10.
- **Protractor - 360°:** This interactive measuring tool can be used to measure angles of any object in any scene. The measuring arm can be moved in 1°, 5°, 10°, 15°, 20°, 30°, or 45° increments, allowing students to dynamically measure angles of any value.

- **Tape Measure:** Interactive at-scale measuring tool. Users can extend the tape in 1-ft segments up to 10 feet.
- **Tape Measure (Metric):** Interactive at-scale measuring tool. Users can extend the tape in $\frac{1}{2}$ meter segments up to 5 meters.
- **Pythagorean Theorem Visualizer:** Interactive visualization of the Pythagorean Theorem. Select values for sides A and B to generate a triangle, then apply the theorem for side C.
- **Revolved Cone:** Visualization of how a 2D right triangle can be revolved into a 3D cone.
- **Revolved Cylinder:** Visualization of how a 2D rectangle can be revolved into a 3D cylinder.
- **Revolved Sphere:** Visualization of how a 2D semicircle can be revolved into a 3D sphere.
- **Ferris Wheel - Sine & Cosine Demo:** Learn about the sine and cosine functions by plotting your position as you ride on a Ferris Wheel.
- **Math Words (3D representation):** Zero | One | Two | Three | Four | Five | Six | Seven | Eight | Nine | Ten | Eleven | Twelve | Thirteen | Fourteen | Fifteen | Sixteen | Seventeen | Eighteen | Nineteen | Twenty | Thirty | Forty | Fifty | Sixty | Seventy | Eighty | Ninety | Hundred | Thousand | Million | Billion | Trillion | And | Point | Th | Ths
- **Metric Volumes:** 1000 mL Beaker | 1-Kiloliter Tank | 1-Liter Bottle | 2-Liter Bottle
- **US/Imperial Volumes:** Gallon | Quart | Pint | Cup | Tablespoon | Teaspoon