andard 2: Operations and Algebraic Thinking Benchmark 1 dd and subtract withi ultiply and divide wit in familiarity with Fluently add and subtract uently add and subtra luently multiply and divid ind all factor pairs for a ind all factor pairs for Operations within 5. and subtraction (e.g., by within 20 using mental within 100, using strategie whole number in the range whole numbers in the range factor of two whole number 1–100. Recognize that a whole number is a multiple counting on 2 to add 2). such as the relationship of 1-100 Determine less than or equal to 100 whether a given whole between multiplication and and the least common number in the range of 1-100 is prime or composite. division or properties of of each of its factors multiple of two whole Determine whether a given numbers less than or equa whole number in the range Find the prime factorization to 12. 1–100 is a multiple of a given one-digit number. Determine whether a given whole number in the range 1\_100 is prime or mposite. Add and subtract within 20. Know from memory all Know from memory all demonstrating fluency for addition and subtraction ums of two one-digit roducts of two one-digit umbers. vithin 10 Benchmark 2 ects to gain indations for ntify and explain Solving Equations Inderstand the meaning etermine whether a group Solve two-step word Senerate a number or Senerate two numerical of objects (up to 20) has a oblems using the four shape pattern that follows a the equal sign, and patterns using two given determine if equations odd or even number of operations. Represent given rule. Identify apparent rules. Identify apparent Ise variables to represent nvolving addition and embers. ese problems using features of the pattern that relationships between two quantities in a realworld problem that change subtraction are true or falequations with a letter were not explicit in the rule corresponding terms. Form ordered pairs consisting of corresponding terms from anding for the unknown in relationship to one another; write an equation quantity. Assess the easonableness of answ the two patterns, and graph to express one quantity thought of as the depende variable, in terms of the using mental computation he ordered pairs on a and estimation strategies coordinate plane. other quantity, thought of as the independent variable. ncluding rounding. Analyze the relationship independent variables using graphs and tables, and elate these to the equation Determine the unknown Jse addition to find the tota lentify arithmetic pattern whole number in an addition number of objects arranged (including patterns in the or subtraction equation relating three whole in rectangular arrays with up to 5 rows and up to 5 iddition table or nultiplication table), and numbers olumns: write an equation explain them using o express the total as a operties of operations. um of equal addends Benchmark 3 tting together and ding to, and unders blems involving ition and subtract ressions. (Linear, onential, quadratic) erations to generate traction as taking Use addition and subtraction within 20 to Use addition and subtraction within 100 to Interpret products of whole numbers. Use parentheses, brackets, or braces in numerical Interpret expressions that represent a quantity in Interpret expressions that represent a quantity in Seeing Structure in Represent addition and Interpret a multiplication Write and evaluate Apply properties of subtraction with objects. equation as a comparison. numerical expressions operations as strategies to Expressions xpressions and evaluate involving whole-number exponents. lingers, mental images, solve word problems solve one- and two-sten add subtract factor and terms, factors, and terms of its context rawings1, sounds (e.g., word problems involving xpressions with these expand linear expressions with rational coefficients. polynomial and rational). nvolving situations of oefficients. claps), acting out situatio adding to, taking from. situations of adding to. vmbols. erbal explanations, outting together, taking king from, putting together, taking apart, and expressions, or equations apart, and comparing, with inknowns in all positions omparing, with unknown all positions. Solve addition and Solve word problems that Interpret whole-number Multiply or divide to solve Write simple expressions Write, read, and evaluate Understand that rewriting Use the structure of an Use the structure of an ubtraction word problems, call for addition of three otients of whole numbers. word problems involving hat record calculations with expressions in which letters an expression in different expression to identify ways and add and subtract within whole numbers whose sun multiplicative comparison. numbers, and interpret stand for numbers. forms in a problem context to rewrite it. to rewrite it (polynomial and umerical expressions vithout evaluating them. s less than or equal to 20. can shed light on the problem and how the uantities in it are relate ecompose numbers less Jse multiplication and Solve multistep word than or equal to 10 into division within 100 to solve pairs in more than one w ord problems in situation problems posed with whole numbers and having whole nvolving equal groups. rrays, and measurement number answers using the four operations, including quantities. problems in which remainders must be interpreted. Represent these problems using equations with a letter standing for the unknown quantity. Assess the reasonableness of answer using mental computation and estimation strategies including rounding.

	For any number from 1 to 9,	,	Determine the unknown						
	find the number that makes		whole number in a multiplication or division						
	10 when added to the given number.	'l	equation relating three						
	number.		whole numbers.						
Benchmark 4		Understand and apply	Understand properties of multiplication and the		Apply properties of	Solve real-life and	Write expressions in	Write expressions in	
		properties of operations and the relationship	multiplication and the relationship between		operations	mathematical problems using numerical and	equivalent forms to solve problems. (Quadratic and	equivalent forms to solve problems. (Quadratic and	
		between addition and	multiplication and			algebraic expressions	exponential)	exponential)	
		subtraction.	division.			and equations			
Expressions and		Apply properties of	Apply properties of		Apply the properties of	Solve multi-step real-life	Choose and produce an	Derive the formula for the	
Equations		operations as strategies to add and subtract.	operations as strategies to multiply and divide.		operations to generate equivalent expressions.	and mathematical problems posed with positive and	equivalent form of an expression to reveal and	sum of a finite geometric series (when the common	
		add and additact.	matapiy and divide.		equivalent expressions.	negative rational numbers	explain properties of the	ratio is not 1), and use the	
						in any form (whole	quantity represented by the	formula to solve problems.∗	
						numbers, fractions, and decimals), using tools	expression.*		
						strategically. Apply			
						properties of operations to			
						calculate with numbers in			
						any form; convert between forms as appropriate; and			
						assess the reasonableness			
						of answers using mental			
						computation and estimation			
						strategies.			
		Understand subtraction as	Understand division as an		Identify when two	Use variables to represent			
		an unknown-addend	unknown-factor problem.		expressions are equivalent	quantities in a real-world or			
		problem. For example, subtract 10 – 8 by finding	For example, find 32 + 8 by finding the number that		(i.e., when the two	mathematical problem, and construct simple equations			
		the number that makes 10	makes 32 when multiplied		number regardless of which	and inequalities to solve			
		when added to 8. Add and	by 8.		value is substituted into	problems by reasoning			
		subtract within 20.			them).	about the quantities.	Destance of the set of	Dardama addissable	
Benchmark 5							Perform arithmetic operations on	Perform arithmetic operations on	
							polynomials. (Linear and	polynomials. (Beyond	
							quadratic)	Quadratic)	
Arithmetic with							Understand that polynomials form a system	Understand that polynomials form a system	
Polynomials and							analogous to the integers,	analogous to the integers,	
Rational Expressions							namely, they are closed	namely, they are closed	
Expressions							under the operations of addition, subtraction, and	under the operations of addition, subtraction, and	
							multiplication; add, subtract,	multiplication; add, subtract,	
							and multiply polynomials.	and multiply polynomials.	
Barrell and the B								Understand the relationship between	
Benchmark 5								zeros and factors of	
(Part 2)								polynomials.	
								Know and apply the Remainder Theorem:	
								Identify zeros of	
								polynomials when suitable	
								factorizations are available,	
								and use the zeros to construct a rough graph of	
								the function defined by the	
								polynomial.	
Benchmark 5								Use polynomial identities to solve problems.	
(Part 3)									
								Prove polynomial identities	
						1		and use them to describe numerical relationships.	
		<u> </u>	 <u> </u>	 		<u> </u>	<u> </u>	 triples.	 
								 (+) Know and apply the	
						İ		Binomial Theorem for the expansion of (x + y)n in	
						İ		powers of x and y for a	
						İ		positive integer n, where x	
						1		and y are any numbers,	
						İ		with coefficients determined for example by Pascal's	
						L		Triangle.1	
Benchmark 5								Rewrite rational	
(Part 4)								expressions.	
								Rewrite simple rational	
						1		expressions in different	
	-	-	<b> </b>			<del>                                     </del>	<del>                                     </del>	forms. (+) Understand that rational	
						1		expressions form a system	
						1		analogous to the rational	
						İ		numbers, closed under addition, subtraction.	
						İ		multiplication, and division	
						İ		by a nonzero rational	
			l			L	L	expression.	

Benchmark 6						Create equations that	Create equations that	
						describe numbers or	describe numbers or	
						relationships (Linear,	relationships (equations	
						quadratic, and	using all available types	
						exponential (integer inputs only) for A.CED.3,	of expressions, including	
						linear only)	simple and root	
Creating Equations						Create equations and	Create equations and	
Creating Equations						inequalities in one variable	inequalities in one variable	
						and use them to solve	and use them to solve	
						problems. Include equations	problems. Include equations	
						arising from linear and	arising from linear and	
						quadratic functions, and	quadratic functions, and	
						simple rational and	simple rational and	
						exponential functions.	exponential functions.	
						Create equations in two or	Create equations in two or	
						more variables to represent relationships between	more variables to represent relationships between	
						quantities; graph equations	quantities; graph equations	
						on coordinate axes with	on coordinate axes with	
						labels and scales.	labels and scales.	
						Represent constraints by	Represent constraints by	
						equations or inequalities,	equations or inequalities,	
					l	and by systems of	and by systems of	
					l	equations and/or	equations and/or	
	J					inequalities, and interpret	inequalities, and interpret solutions as viable or non-	
	J					solutions as viable or non- viable options in a modeling	viable options in a modeling	
	J					context	context.	
	J					Rearrange formulas to	Rearrange formulas to	
	J					highlight a quantity of	highlight a quantity of	
					l	interest, using the same	interest, using the same	
	J					reasoning as in solving	reasoning as in solving	
						equations. For example,	equations. For example,	
						rearrange Ohm's law V = IR	rearrange Ohm's law V = IR	
				Reason about and solve	Hardanston data	to highlight resistance R.	to highlight resistance R.	
Benchmark 7				one-variable equations	Understand the connections between	Understand solving	Understand solving	
(Part 1)				and inequalities.	proportional	equations as a process of	equations as a process of	
,					relationships, lines, and	reasoning and explain the	reasoning and explain the	
					linear equations.	reasoning (Master linear,	reasoning (Simple radical	
					•	learn as general principle)	and rational)	
Reasoning with				Understand solving an	Graph proportional	Explain each step in solving	Solve simple rational and	
Reasoning with Equations and				equation or inequality as a	relationships, interpreting	Explain each step in solving a simple equation as	Solve simple rational and radical equations in one	
Equations and				equation or inequality as a process of answering a	relationships, interpreting the unit rate as the slope of	Explain each step in solving a simple equation as following from the equality	Solve simple rational and radical equations in one variable, and give examples	
Reasoning with Equations and Inequalities				equation or inequality as a process of answering a question: which values from	relationships, interpreting the unit rate as the slope of the graph. Compare two	Explain each step in solving a simple equation as following from the equality of numbers asserted at the	Solve simple rational and radical equations in one variable, and give examples showing how extraneous	
Equations and				equation or inequality as a process of answering a question: which values from a specified set, if any, make	relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional	Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from	Solve simple rational and radical equations in one variable, and give examples	
Equations and				equation or inequality as a process of answering a question: which values from a specified set, if any, make the equation or inequality	relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in	Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the	Solve simple rational and radical equations in one variable, and give examples showing how extraneous	
Equations and				equation or inequality as a process of answering a question: which values from a specified set, if any, make	relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional	Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a	Solve simple rational and radical equations in one variable, and give examples showing how extraneous	
Equations and				equation or inequality as a process of answering a question: which values from a specified set, if any, make the equation or inequality	relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in	Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the	Solve simple rational and radical equations in one variable, and give examples showing how extraneous	
Equations and				equation or inequality as a process of answering a question: which values from a specified set, if any, make the equation or inequality	relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in	Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable	Solve simple rational and radical equations in one variable, and give examples showing how extraneous	
Equations and				equation or inequality as a process of answering a question: which values from a specified set, if any, make the equation or inequality true?	relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways.	Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a	Solve simple rational and radical equations in one variable, and give examples showing how extraneous	
Equations and				equation or inequality as a process of answering a question: which values from a specified set, if any, make the equation or inequality true?  Use variables to represent	relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways.	Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a	Solve simple rational and radical equations in one variable, and give examples showing how extraneous	
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Equations and				equation or inequality as a process of answering a question: which values from a specified set, if any, make the equation or inequality true?  Use variables to represent numbers and write expressions when solving a	relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways.  Use similar triangles to explain why the slope m is the same between any two	Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a	Solve simple rational and radical equations in one variable, and give examples showing how extraneous	
Equations and				equation or inequality as a process of answering a question: which values from a specified set, if any, make the equation or inequality true?  Use variables to represent numbers and write expressions when solving a real-world or mathematical	relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways.  Use similar triangles to explain why the slope m is the same between any two distinct points on a non-	Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a	Solve simple rational and radical equations in one variable, and give examples showing how extraneous	
Equations and				equation or inequality as a process of answering a question: which values from a specified set [" any, make the equation or inequality true?  Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an	relationships, interpreting the unit rate as the slope of the graph. Compare two different propriorional relationships represented in different ways.  Use similar triangles to explain why the slope m is the same between any two distinct points on a non-vertical line in the coordinate plane; derive their distinct points on a non-vertical line in the	Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a	Solve simple rational and radical equations in one variable, and give examples showing how extraneous	
Equations and				equation or inequality as a question, which values from a sportide set, if any, make the equation or inequality true?  Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a	relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways.  Use similar triangles to explain why the slope mis the same between any two distinct points on a non-vertical line in the coordinate plane; derive the coordinate plane; derive the country of the country of the coordinate plane; derive the country of the country	Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a	Solve simple rational and radical equations in one variable, and give examples showing how extraneous	
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Equations and				equation or inequality as a process of answering a question: which values from a specified set if any, make the equation or inequality true?  Use variables to represent numbers and write expressions when solving a real-world or anthernatical problem, understand that a variable can represent an unknown number.  Solve real-world and mathematical problems by writing and solving equations of the form x + p = q and px = q for cases in which p, q and x are all	relationships, interpreting the unit rate as the slope of the graph. Compare two different propriorial relationships represented in different ways.  Use similar triangles to explain why the slope m is the same between any two distinct points on a non-vertical line in the coordinate plane; derive the equation y = mx for a line through the origin and the equation y = mx + b for a line intercepting the vertical.	Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a	Solve simple rational and radical equations in one variable, and give examples showing how extraneous	
Equations and				equation or inequality as a process of answering a question. which values from a specified set if any, make the equation or inequality true?  Use variables to represent numbers and write expressions when solving a real-world or mathematical problem, understand that a variable can represent an unknown number.  Solve real-world and mathematical problems to design a quality of the control of the	relationships, interpreting the unit rate as the slope of the graph. Compare two different propriorial relationships represented in different ways.  Use similar triangles to explain why the slope m is the same between any two distinct points on a non-vertical line in the coordinate plane; derive the equation y = mx for a line through the origin and the equation y = mx + b for a line intercepting the vertical.	Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a	Solve simple rational and radical equations in one variable, and give examples showing how extraneous	
Equations and				equation or inequality as a process of answering a question: which values from a specified set if any, make the equation or inequality true?  Use variables to represent numbers and write expressions when solving a real-world or anthematical problem; understand that a variable can represent an unknown number.  Solve real-world and mathematical problems by writing and solving equations of the form x + p = q and px = q for cases in which p, q and x are all nonnegative rational numbers.	relationships, interpreting the unit rate as the slope of the graph. Compare two different propriorial relationships represented in different ways.  Use similar triangles to explain why the slope m is the same between any two distinct points on a non-vertical line in the coordinate plane; derive the equation y = mx for a line through the origin and the equation y = mx + b for a line intercepting the vertical.	Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a	Solve simple rational and radical equations in one variable, and give examples showing how extraneous	
Equations and				equation or inequality as a process of answering a question, which values from a specified set if any, make the equation or inequality true?  Use variables to represent numbers and write expressions when solving a real-world or mathematical problem, understand that a variable can represent an unknown number.  Solve real-world and mathematical problems to write and solving with the problems of th	relationships, interpreting the unit rate as the slope of the graph. Compare two different propriorial relationships represented in different ways.  Use similar triangles to explain why the slope m is the same between any two distinct points on a non-vertical line in the coordinate plane; derive the equation y = mx for a line through the origin and the equation y = mx + b for a line intercepting the vertical.	Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a	Solve simple rational and radical equations in one variable, and give examples showing how extraneous	
Equations and				equation or inequality as a process of answering a question: which values from a specified set if any, make the equation or inequality true?  Use variables to represent numbers and write expressions when solving a real-world or anthematical problem; understand that a variable can represent an unknown number.  Solve real-world and mathematical problem by writing and solving equations of the form x + p = q and px = q for cases in which p, q and x are all nonnegative rational unknown inequality of the form x + core to the control of the control of the form x + p = q and px = q for cases in which p, q and x are all nonnegative rational numbers.  Write an inequality of the form x + core to the control of the form x + core x + core to the core x + core x	relationships, interpreting the unit rate as the slope of the graph. Compare two different propriorial relationships represented in different ways.  Use similar triangles to explain why the slope m is the same between any two distinct points on a non-vertical line in the coordinate plane; derive the equation y = mx for a line through the origin and the equation y = mx + b for a line intercepting the vertical.	Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a	Solve simple rational and radical equations in one variable, and give examples showing how extraneous	
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					Analyze and solve pairs of	Solve systems of two linear			
					simultaneous linear	equations in two variables			
					equations.	algebraically, and estimate			
					equations.	solutions by graphing the			
						equations. Solve simple			
						cases by inspection.			
						Solve real-world and		+	
						mathematical problems			
						leading to two linear			
						equations in two variables.			
Benchmark 7						Solve systems of		Solve systems of	
(Part 3)						equations ( Linear-linear,		equations.	
(Part 3)						and linear-quadratic)			
						Prove that, given a system		(+) Represent a system of	
						of two equations in two		linear equations as a single	
						variables, replacing one		matrix equation in a vector	
						equation by the sum of that		variable.	
						equation and a multiple of			
						the other produces a			
						system with the same			
						solutions.			
	H					SUIULIUNS.		(1) Find the inverse of -	
	l					Solve systems of linear		(+) Find the inverse of a	
	l					Solve systems of linear		matrix if it exists and use it	
	l					equations exactly and		to solve systems of linear	
	l					approximately (e.g., with		equations (using technology	
	l					graphs), focusing on pairs		for matrices of dimension 3	
	l					of linear equations in two		× 3 or greater).	
	l					variables.		· · ·	
		i				Solve a simple system		i	
	l					consisting of a linear		I	
						equation and a quadratic			
						equation in two variables			
						equation in two variables			
						algebraically and			
						graphically.			
						Represent and solve	Represent and solve		
						equations and inequalities graphically (Linear and	equations and inequalities graphically (Combine		
						graphically (Linear and	graphically (Combine		
						exponential; learn as	polynomial, rational,		
Benchmark 7						general principle)	radical, absolute value,		
						g	and exponential		
(Part 4)							functions)		
( /						Understand that the graph	Tulicuolis)		
						of an equation in two			
						variables is the set of all its			
						valiables is the set of all its			
						solutions plotted in the			
						coordinate plane, often			
						forming a curve (which could be a line).			
						could be a line).			
						Explain why the x-	Explain why the x-		
	l					coordinates of the points	coordinates of the points	I	
	l					where the graphs of the	where the graphs of the	I	
	l					equations y = f(x) and y =	equations y = f(x) and y =	I	
	l					g(x) intersect are solutions	g(x) intersect are the	I	
	l					of the equation f(x) = g(x);	solutions of the equation f(x)	I	
						find the solutions	= g(x); find the solutions	I	
	l					approximately, e.g., using	approximately, e.g., using	I	
	l					approximately, e.g., using	approximately, e.g., uSING	I	
	l					technology to graph the function , make table of	technology to graph the functions, make tables of	I	
	l							I	
	l					values, or find successive	values, or find successive	I	
	l					approximations. Include	approximations. Include	I	
	l					cases where f(x) and/or g(x)	cases where f(x) and/or g(x)	I	
	l					are linear, polynomial,	are linear, polynomial,	I	
	l					rational, absolute value,	rational, absolute value,	I	
	l					exponential, and logarithmic	exponential, and logarithmic	I	
	l					functions.	functions.*	I	
	l					1	-	I	
						Graph the solutions to a		- t	
	l					linear inequality in two		I	
	l					variables as a half- plane		I	
	l					(excluding the boundary in		I	
	l					the case of a strict		I	
	l								
	1					inequality), and graph the		I	
	l					solution set to a system of		I	
	l					linear inequalities in two		I	
	l					variables as the intersection		I	
	l					of the corresponding half-		I	
	l					planes		I	