

Richmond Public Schools
Curriculum Framework
Grade 8

Strand: Patterns, Functions, and Algebra	
8.17 The student will solve multistep linear equations in one variable with the variable on one or both sides of the equation, including practical problems that require the solution of a multistep linear equation in one variable.	
Suggested Pacing	
First Nine Weeks – 10 Instructional Days (including common assessment)	
Related Standards	
<p>Spiral Down</p> <p>7.12 The student will solve two-step linear equations in one variable, including practical problems that require the solution of a two-step linear equation in one variable.</p> <p>6.13 The student will solve one-step linear equations in one variable, including practical problems that require the solution of a one-step linear equation in one variable.</p>	<p>Spiral Up</p> <p>A.4 The student will solve</p> <p>a) multistep linear equations in one variable algebraically.</p>
Essential Questions	Common Misconceptions
<p>Describe how to solve a multi-step equation. <i>To solve a multi-step equation, use the distributive property if necessary, combine like terms if necessary, then use inverse operations to isolate the variable.</i></p> <p>Describe a verbal expression. <i>Numbers are used when they are known; variables are used when the numbers are unknown.</i></p> <p>Describe an algebraic expression. <i>A phrase that does not have an equal sign and contains at least one variable.</i></p>	<ul style="list-style-type: none"> ● Students have trouble combining like terms, students will attempt to add or subtract variable terms and constants. ● Students have trouble applying the inverse operation when the coefficients that are fractions or negative one. ● Students have difficulty identifying and distinguishing between the applications of properties when used to solve multi-step equations. ● Students need to practice using an algorithm or steps necessary to solve multi-step equations.

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Understanding the Standard	Essential Knowledge and Skills
<ul style="list-style-type: none"> ● A multistep equation may include, but not be limited to equations such as the following: $2x + 1 = \frac{-x}{4}; -3(2x + 7) = \frac{1}{2}x; 2x + 7 - 5x = 27;$ $-5x - (x + 3) = -12.$ ● An expression is a representation of quantity. It may contain numbers, variables, and/or operation symbols. It does not have an “equal sign (=)” (e.g., $\frac{3}{4}$, $5x$, $140 - 38.2$, $18 \cdot 21$, $5 + x$.) ● An expression that contains a variable is a variable expression. A variable expression is like a phrase: as a phrase does not have a verb, so an expression does not have an “equal sign (=)”. An expression cannot be solved. ● A verbal expression can be represented by a variable expression. Numbers are used when they are known; variables are used when the numbers are unknown. For example, the verbal expression “a number multiplied by five” could be represented by the variable expression “$n \cdot 5$” or “$5n$”. ● An algebraic expression is a variable expression that contains at least one variable (e.g., $2x - 3$). ● A verbal sentence is a complete word statement (e.g., “The sum of two consecutive integers is thirty-five.” could be represented by “$n + (n + 1) = 35$”). ● An algebraic equation is a mathematical statement that says that two expressions are equal (e.g., $2x + 3 = -4x + 1$). 	<p>The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to</p> <ul style="list-style-type: none"> ● Represent and solve multistep linear equations in one variable with the variable on one or both sides of the equation (up to four steps) using a variety of concrete materials and pictorial representations. ● Apply properties of real numbers and properties of equality to solve multistep linear equations in one variable (up to four steps). Coefficients and numeric terms will be rational. Equations may contain expressions that need to be expanded (using the distributive property) or require collecting like terms to solve. ● Write verbal expressions and sentences as algebraic expressions and equations. ● Write algebraic expressions and equations as verbal expressions and sentences. ● Solve practical problems that require the solution of a multistep linear equation. ● Confirm algebraic solutions to linear equations in one variable.

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- In an equation, the “equal sign (=)” indicates that the value of the expression on the left is equivalent to the value of the expression on the right.
- Like terms are terms that have the same variables and exponents. The coefficients do not need to match (e.g., $12x$ and $-5x$; 45 and $-5\frac{2}{3}$; $9y$, $-51y$ and $\frac{4}{9}y$.)
- Like terms may be added or subtracted using the distributive and other properties. For example,
 - $4.6y - 5y = (-4.6 - 5)y = -9.6y$
 - $w + w - 2w = (1 + 1)w - 2w = 2w - 2w = (2 - 2)w = 0 \cdot w = 0$
- Real-world problems can be interpreted, represented, and solved using linear equations in one variable.
- Properties of real numbers and properties of equality can be used to solve equations, justify solutions and express simplification. Students should use the following properties, where appropriate, to further develop flexibility and fluency in problem solving (limitations may exist for the values of a , b , or c in this standard):
 - Commutative property of addition: $a + b = b + a$.
 - Commutative property of multiplication: $a \cdot b = b \cdot a$.
 - Associative property of addition: $(a + b) + c = a + (b + c)$.
 - Associative property of multiplication: $(a \cdot b) \cdot c = a \cdot (b \cdot c)$.
 - Subtraction and division are neither commutative nor associative.
 - Distributive property (over addition/subtraction):
 $a \cdot (b + c) = a \cdot b + a \cdot c$ and $a \cdot (b - c) = a \cdot b - a \cdot c$.

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- The additive identity is zero (0) because any number added to zero is the number. The multiplicative identity is one (1) because any number multiplied by one is the number. There are no identity elements for subtraction and division.
- Identity property of addition (additive identity property):
 $a + 0 = a$ and $0 + a = a$.
- Identity property of multiplication (multiplicative identity property): $a \cdot 1 = a$ and $1 \cdot a = a$.
- Inverses are numbers that combine with other numbers and result in identity elements
(e.g., $5 + (-5) = 0$; $\frac{1}{5} \cdot 5 = 1$).
- Inverse property of addition (additive inverse property):
 $a + (-a) = 0$ and $(-a) + a = 0$.
- Inverse property of multiplication (multiplicative inverse property): $a \cdot \frac{1}{a} = 1$ and $\frac{1}{a} \cdot a = 1$.
- Zero has no multiplicative inverse.
- Multiplicative property of zero: $a \cdot 0 = 0$ and $0 \cdot a = 0$.
- Division by zero is not a possible mathematical operation. It is undefined.

- Substitution property: If $a = b$, then b can be substituted for a in any expression, equation, or inequality.
- Addition property of equality: If $a = b$, then $a + c = b + c$.
- Subtraction property of equality: If $a = b$, then $a - c = b - c$.

- Multiplication property of equality: If $a = b$, then $a \cdot c = b \cdot c$.

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<p>- Division property of equality: If $a = b$ and $c \neq 0$, then $\frac{a}{c} = \frac{b}{c}$.</p>	
Vocabulary	Instructional Activities Organized by Learning Objective
<p>Multistep Linear Equation Variables Solution Operations Coefficients Constants Term Expression Variable Expression Verbal Expression Algebraic Expression Verbal Sentence Algebraic Equation Like Terms Justify Commutative Property of Addition Commutative Property of Multiplication Associative Property of Addition Associative Property of Multiplication Distributive Property (over addition/subtraction) Additive Identity Multiplicative Identity Identity Property of Addition (additive identity property) Identity Property of Multiplication (multiplicative identity property) Inverse Property of Addition (additive inverse property) Inverse Property of Multiplication (multiplicative inverse property) Multiplicative Property of Zero Substitution Property</p>	<p>Virginia Department of Education <u>Solving Equations</u> – Lesson Plan <u>Properties of Operations</u> – Lesson Plan</p> <p>Textbook <i>Virginia Pre-Algebra, ©2012, Glencoe/McGraw-Hill</i></p> <ul style="list-style-type: none"> ● Simplifying Expressions by Combining Like Terms, page(s) 180 – 185 ● Solving Equations by Adding and Subtracting, page(s) 186 – 191 ● Solving Equations by Multiplying and Dividing, page(s) 193 – 200 ● Solving Two Step Equations, page(s) 201 – 206 ● Writing Equations, page(s) 207 - 211 ● Solving Equations with Variables on Each Side, page(s) 230 - 235 <p>Notes</p> <ul style="list-style-type: none"> ● Multi-step Equations and Properties <p>Resources</p> <ul style="list-style-type: none"> ● Print <i>Virginia Coach</i>, NEW SOL Edition, Grade 8, Mathematics Lesson 22 – page 163 (Solve Linear Equations) ● Technology-based <ul style="list-style-type: none"> ○ <i>ExploreLearning.com</i> – Modeling and Solving Two-Step Equations – Interactive Instructional Resource

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Addition Property of Equality Subtraction Property of Equality Multiplication Property of Equality Division Property of Equality	<ul style="list-style-type: none"> o <i>Exchange.Smarttech.com (SMART Board) – Solving Equations - SMART Notebook Lesson – *SMART Board required</i>
Assessment	Station Activities
<p>RPS PowerSchool Unit Test – RPS 8.17 Common Assessment Test ID#:</p> <p>Formative Assessments White Board Checks Kahoot.it Plickers Exit Tickets Graphic Organizers Venn Diagrams</p>	<ul style="list-style-type: none"> ● Multistep Equation Foldable - Have students create a foldable, describing characteristics, providing examples, and relationships. ● Find and Fix the Errors - Give students cards that have equations that have been solved with the most common misconceptions and have student find and fix the errors. ● Multistep Equation Task Cards - Have students complete problems in small groups Think-Pair-Share. ● MultiStep Equations Relay Race: Directions & Activity ● Solving Equations - Partner Play
Cross-Curricular Connections	Differentiations
<p>English Have students write to an absent student about how to solve a multi-step equation.</p> <p>Science Relate to Physical Science and solving Distance/Time equations.</p>	<ul style="list-style-type: none"> ● Have students put a box around variable terms and a circle around constants. This will help with combining like terms. ● Give students a balance template and have them start solving one-step equations and discuss the process. Progress to a two-step equation and then a multi-step equation and discuss the similarities. ● Have students make a flowchart (Yes or No) to help with steps to solve multi-step equations. ● Have students highlight all operations to make sure as they go step by step so they do not forget what to take the inverse of.