Amplify Math TENNESSEE

Algebra 1

Teacher Edition

About Amplify

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A pioneer in K–12 education since 2000, Amplify is leading the way in next-generation curriculum and assessment. All of our programs provide teachers with powerful tools that help them understand and respond to the needs of every student.

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Volume 1

Unit 1 Linear Equations, Inequalities, and Systems

In this unit, students write and solve linear equations and inequalities to model the relationship between different quantities, recalling what is meant by a solution to an equation and interpreting solutions in context. They also solve systems of linear equations by graphing and using substitution and elimination methods.

Unit Narrative:
Adulting (Making Life Decisions)

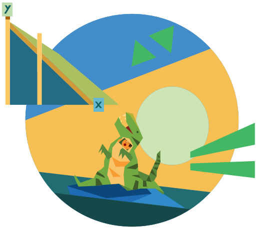
● = *Tennessee-specific lessons*

Sub-Unit Narrative:
How did a tragic accident end a three-month strike?
Revisit how equations and inequalities can be used to model real-world situations, and how they can help you make decisions.

Sub-Unit Narrative:
How do first-gen Americans vault the hurdles of college?
"Solving" an equation doesn't always mean finding an unknown value — sometimes it can mean changing the equation's very structure.

Sub-Unit Narrative:
What's after high school?
Whether you work, intern, attend college, or do something else, inequalities can be used to model your time and money, helping you manage both of them.

● = *Tennessee-specific lessons*



Sub-Unit 4 Systems of Linear Equations in Two Variables

Sub-Unit Narrative:
Are you a “boomerang-er”?
For better or for worse, life is full of constraints. Discover new strategies for solving problems with multiple constraints, which you will see time and again.

Sub-Unit 5 Systems of Linear Inequalities in Two Variables

Sub-Unit Narrative:
Is there such a thing as too much choice?
What happens when the decisions become more complicated? Look at the big picture and then fine-tune where the decision overlaps.

Unit 2 Data Analysis and Statistics

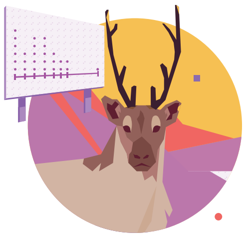
Students will explore univariate and bivariate data sets, many of which relate to climate change. Along the way, they will investigate, calculate, and interpret descriptive statistics, including measures of center, variability, and association.

Unit Narrative:
Analyzing Climate Change

Note: *Lessons in gray are recommended to be omitted.*

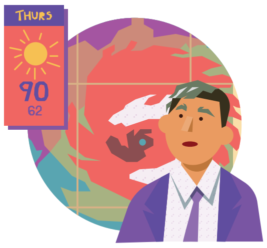
PRE-UNIT READINESS ASSESSMENT

LAUNCH



Sub-Unit 1 Data Distributions 211

Sub-Unit Narrative:
How can we protect ourselves from a zombie virus?
Remember dot plots, histograms, and box plots? Revisit them through temperature data, while describing the data's center and variability.



Sub-Unit 2 Standard Deviation 251

Sub-Unit Narrative:
Is Sandy the new normal?
Meet the most commonly used measure of variability: standard deviation.

Sub-Unit 3 Bivariate Data 285

Sub-Unit Narrative:
What is "Day Zero"?
You have seen linear models before, but now you will (finally!) see how to identify the "best" model, by looking carefully at what are called residuals.

Note: *Lessons in gray are recommended to be omitted.*

Sub-Unit Narrative:
What makes storms worse and has nothing to do with weather?

Use two-way tables to see how the changing climate has affected marginalized people around the world.

Sub-Unit Narrative:
Who is the "water warrior"?

Finally, you can say just how strong or weak an association is using a new statistical measure: the ***correlation coefficient***.

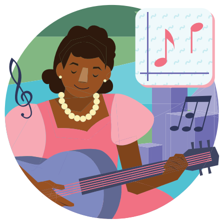
Unit 3 Functions and Their Graphs

Students will expand on their understanding of the key features and multiple representations of functions. Along the way, they will write, graph, and interpret linear functions, piecewise functions, absolute functions, and the inverse of functions.

Unit Narrative:
Artscapes

PRE-UNIT READINESS ASSESSMENT

LAUNCH



Sub-Unit 1 Functions and Their Representations

Sub-Unit Narrative:
How did the blues find a home in Memphis?

Remember representing functions with description, tables, graphs, and equations? Take another look as you visit Memphis, and meet another common tool to represent and interpret functions: function notation.

Sub-Unit 2 Analyzing and Creating Graphs of Functions

Sub-Unit Narrative:
What's the function of a jazz solo?

The way you describe a graph helps you gain insight on the relationship it represents. Average rate of change, domain, and range help to construct and interpret graphs more precisely.

Note: *Lessons in gray are recommended to be omitted.*

Sub-Unit Narrative:
Where did the world meet soul?

Piecewise functions allow you to represent a relationship between two quantities as a set of rules. The absolute value function is a specific piecewise function that represents the distance from zero.

Sub-Unit Narrative:
How do you get Sunday shoppers to hear your song?

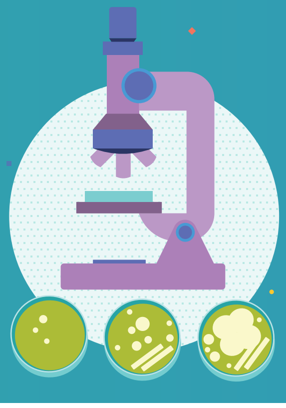
What happens if you reverse the process used in a relationship between two quantities? What changes? What stays the same? You can explore these questions using inverses of functions.

Volume 2

Unit 4 Introducing Exponential Functions

This is a unit of mathematical discovery, where the relationship between quantities is unlike any function students will have seen up to this point. Students encounter the explosiveness of exponential growth and and lingering of exponential decay through applications of infectious disease, vaccination, and prescription drug costs.

Unit Narrative:
Infectious Diseases, Vaccines, and Costs



Sub-Unit Narrative:
Where do baby bacteria come from?

Examine nonlinear functions using tables and graphs, before defining an exponential relationship. You'll represent exponential growth using an equation and explore it in context.

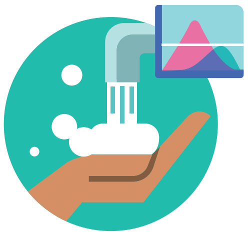
Sub-Unit Narrative:
How did an enslaved person save the city of Boston?

Examine growth factors between 0 and 1 as you develop an understanding of exponential decay.

Sub-Unit Narrative:
What does growing and shrinking look like on a graph?

Identify exponential relationships as exponential functions, and determine whether a graph is discrete.

Sub-Unit Narrative:
Want to be CEO for a day?
Make sense of repeated percent increase and see how it relates to compound interest.



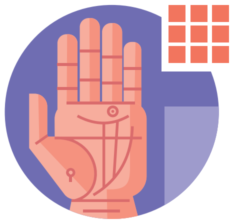
Sub-Unit Narrative:
Does distance make the curve grow flatter?
Compare the growth of different kinds of functions and finish with an exploration of how social distancing can combat the dangers of an epidemic.

Unit 5 Introducing Quadratic Functions

Students study quadratic functions. By analyzing and comparing patterns, tables, graphs, and equations, they gain an appreciation for the special features of quadratic functions and the situations they represent.

Unit Narrative:
Squares in Motion

● = *Tennessee-specific lessons*



Sub-Unit Narrative:
What's the best shape for a crystal ball?
Dive into quadratic expression by examining patterns of growth and change.

Sub-Unit Narrative:
What would sports be like without quadratics?
Use quadratic functions to model objects flying through the air or revenues earned by companies.

Sub-Unit Narrative:
How do you put the "quad-" in quadratics?
Use area diagrams and algebra tiles to factor quadratic expressions as you explore equivalent ways to write them.

Sub-Unit Narrative:
Mirror, mirror on the wall, what's the fairest function of them all?

Quadratics have their own beauty, and different forms help you identify features of their graphs.

Unit 6 Quadratic Equations

In this unit, students write and solve quadratic equations and make sense of the solutions. They investigate the structure of quadratic equations and determine efficient strategies for solving them.

Unit Narrative:
The Evolution of Solving Quadratic Equations

● = *Tennessee-specific lessons*

Sub-Unit Narrative:
How did the Nile River spur on Egyptian mathematics?
Revisit projectile motion and maximizing revenue as you discover new meanings for the zeros of a quadratic function.

Sub-Unit Narrative:
When is zero more than nothing?
Understand the importance of zero when solving quadratic equations. Then, efficiently factor quadratics using a variety of strategies.

Sub-Unit Narrative:
How many ways can you crack an egg?
Discover the ancient art of taking a quadratic expression and completing the square. It's all about that missing piece.

Note: *Lessons in gray are recommended to be omitted.*

Sub-Unit Narrative:
Where does a number call its home?

Subtraction and division took you from whole numbers to rationals. Now you must look beyond them as you operate with irrational numbers.

Sub-Unit Narrative:
What was the House of Wisdom?

Discover strategies for solving any quadratic equation. You will also determine which strategies are more efficient.

Tennessee Mathematics Standards, Algebra 1

Note: Mathematical modeling standards are denoted by the asterisk (*).

A1.N	**Quantities***	**Lesson(s)**
A1.N.Q	**Reason quantitatively and use units to solve problems.**	
A1.N.Q.A.1	Use units as a way to understand real-world problems.*	**Unit 1, Lesson** 1 **Unit 3, Lesson** 8 **Unit 4, Lesson** 7
A1.N.Q.A.1a	Choose and interpret the scale and the origin in graphs and data displays.*	**Unit 3, Lesson** 8 **Unit 4, Lessons** 7, 10, 20
A1.N.Q.A.1b	Use appropriate quantities in formulas, converting units as necessary.*	**Unit 5, Lessons** 2, 7, 8
A1.N.Q.A.1c	Define and justify appropriate quantities within a context for the purpose of modeling.*	**Unit 1, Lessons** 1, 25 **Please also see the Mathematical Modeling Prompts 1–9 as part of Additional Practice provided for Algebra 1.**
A1.N.Q.A.1d	Choose an appropriate level of accuracy when reporting quantities.*	**Unit 2, Lesson** 13 **Unit 4, Lessons** 12, 22
A1.A.SSE	**Seeing Structure in Expressions***	**Lesson(s)**
A1.A.SSE.A	**Interpret the structure of expressions.**	
A1.A.SSE.A.1	Interpret expressions that represent a quantity in terms of its context.*	**Unit 4, Lesson** 19 **Unit 5, Lessons** 3, 5–7, 10, 23 **Unit 6, Lessons** 1, 2, 4, 9
A1.A.SSE.A.1a	Interpret parts of an expression, such as terms, factors, and coefficients.*	**Unit 4, Lessons** 4, 5, 15–18 **Unit 5, Lessons** 11A, 23
A1.A.SSE.A.1b	Interpret complicated expressions by viewing one or more of their parts as a single entity.*	**Unit 4, Lessons** 18, 19, 21
A1.A.APR	**Arithmetic with Polynomials and Rational Expressions**	**Lesson(s)**
A1.A.APR.A	**Perform arithmetic operations on polynomials.**	
A1.A.APR.A.1	Add, subtract, and multiply polynomials. Use these operations to demonstrate that polynomials form a closed system that adhere to the same properties of operations as the integers.	**Unit 5, Lesson** 11A

Tennessee Mathematics Standards, Algebra 1

Note: Mathematical modeling standards are denoted by the asterisk (*).

A1.A.CED	**Creating Equations***	**Lesson(s)**
A1.A.CED.A	**Create equations that describe numbers or relationships.**	
A1.A.CED.A.1	Create equations and inequalities in one variable and use them to solve problems in a real-world context.*	**Unit 1, Lesson** 13 **Unit 6, Lessons** 1, 2, 22
A1.A.CED.A.2	Create equations in two variables to represent relationships between quantities and use them to solve problems in a real-world context. Graph equations with two variables on coordinate axes with labels and scales, and use the graphs to make predictions.*	**Unit 1, Lessons** 2, 3, 6, 7, 9, 26 **Unit 4, Lessons** 4–6, 8–10 **Unit 6, Lesson** 24
A1.A.CED.A.3	Create individual and systems of equations and/or inequalities to represent constraints in a contextual situation, and interpret solutions as viable or non-viable.*	**Unit 1, Lessons** 2–6, 10, 11, 13, 16, 17, 22, 24–26 **Unit 6, Lesson** 1
A1.A.CED.A.4	Rearrange formulas to isolate a quantity of interest using algebraic reasoning.	**Unit 1, Lessons** 9–12
A1.A.REI	**Reasoning with Equations and Inequalities**	**Lesson(s)**
A1.A.REI.A	**Understand solving equations as a process of reasoning and explain the reasoning.**	
A1.A.REI.A.1	Understand solving equations as a process of reasoning and explain the reasoning. Construct a viable argument to justify a solution method.	**Unit 1, Lessons** 7, 8 **Unit 3, Lesson** 6 **Unit 6, Lessons** 2–5
A1.A.REI.B	**Solve equations and inequalities in one variable.**	
A1.A.REI.B.2	Solve linear and absolute value equations and inequalities in one variable.	**Unit 1, Lesson** 14
A1.A.REI.B.2a	Solve linear equations and inequalities, including compound inequalities, in one variable. Represent solutions algebraically and graphically.	**Unit 1, Lessons** 4, 9, 10, 12A, 13 **Unit 6, Lessons** 2, 4
A1.A.REI.B.2b	Solve absolute value equations and inequalities in one variable. Represent solutions algebraically and graphically.	**Unit 1, Lessons** 12B, 12C
A1.A.REI.B.3	Solve quadratic equations and inequalities in one variable.	**Unit 6, Lessons** 2, 4, 5, 9, 22, 24
A1.A.REI.B.3a	Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, completing the square, knowing and applying the quadratic formula, and factoring, as appropriate to the initial form of the equation. Recognize when a quadratic equation has solutions that are not real numbers.	**Unit 6, Lessons** 3, 5–11, 13, 15, 15A, 16, 18–22
A1.A.REI.B.3b	Solve quadratic inequalities using the graph of the related quadratic equation.	**Unit 6, Lesson** 15A

Note: Mathematical modeling standards are denoted by the asterisk (*).

A1.A.REI.C	**Solve systems of equations.**	
A1.A.REI.C.4	Write and solve a system of linear equations in context.*	**Unit 1, Lessons** 17–22
A1.A.REI.D	**Represent and solve equations and inequalities graphically**	
A1.A.REI.D.5	Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).	**Unit 1, Lessons** 6, 11, 12 **Unit 6, Lesson** 5
A1.A.REI.D.6	Explain why the x-coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$. Find approximate solutions by graphing the functions or making a table of values, using technology when appropriate.*	**Unit 3, Lesson** 6
A1.A.REI.D.7	Graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.	**Unit 1, Lessons** 15, 16, 23–26
A1.F.IF	**Interpreting Functions**	**Lesson(s)**
A1.F.IF.A	**Understand the concept of function and use function notation.**	
A1.F.IF.A.1	Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then $f(x)$ denotes the output of f corresponding to the input x. The graph of f is the graph of the equation $y = f(x)$.	**Unit 3, Lessons** 1–3, 5, 11 **Unit 4, Lesson** 10
A1.F.IF.A.2	Use function notation.*	**Unit 3, Lessons** 3, 5, 6, 14, 15, 22 **Unit 4, Lesson** 19 **Unit 5, Lesson** 5 **Unit 6, Lesson** 21
A1.F.IF.A.2a	Use function notation to evaluate functions for inputs in their domains, including functions of two variables.*	**Unit 3, Lessons** 4, 14 **Unit 4, Lesson** 11 **Unit 5, Lessons** 14, 18
A1.F.IF.A.2b	Interpret statements that use function notation in terms of a context.*	**Unit 3, Lessons** 3, 4 **Unit 4, Lesson** 11
A1.F.IF.A.3	Understand geometric formulas as functions.*	**Unit 3, Lesson** 5 **Unit 6, Lessons** 2, 5

Tennessee Mathematics Standards, Algebra 1

Note: Mathematical modeling standards are denoted by the asterisk (*).

A1.F.IF.B	**Interpret functions that arise in applications in terms of the context.**	
A1.F.IF.B.4	For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship.*	**Unit 3, Lessons** 1–7, 11–14, 22 **Unit 4, Lessons** 7, 8, 10, 13 **Unit 5, Lessons** 1, 2, 9, 13–15, 18–20, 22 **Unit 6, Lessons** 1, 10
A1.F.IF.B.5	Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.*	**Unit 3, Lessons** 8, 10, 11, 14, 15 **Unit 4, Lessons** 10–12 **Unit 5, Lessons** 8, 9, 15
A1.F.IF.B.6	Calculate and interpret the average rate of change of a function (presented algebraically or as a table) over a specified interval. Estimate and interpret the rate of change from a graph.*	**Unit 3, Lessons** 9, 12, 13, 22 **Unit 4, Lessons** 14, 16, 22
A1.F.IF.C	**Analyze functions using different representations.**	
A1.F.IF.C.7	Graph functions expressed algebraically and show key features of the graph, by hand and using technology.*	**Unit 3, Lessons** 5, 6, 14, 22 **Unit 4, Lessons** 6, 7, 11, 13, 16, 20 **Unit 5, Lessons** 8, 9, 14–18, 20–22
A1.F.IF.C.8	Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.*	**Unit 4, Lessons** 18, 19, 21 **Unit 5, Lessons** 17–21 **Unit 6, Lesson** 24
A1.F.IF.C.8a	Rewrite quadratic functions to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a real-world context.	**Unit 5, Lessons** 14, 19 **Unit 6, Lessons** 9, 14
A1.F.IF.C.9	Compare properties of functions represented algebraically, graphically, numerically in tables, or by verbal descriptions.*	**Unit 4, Lessons** 2, 21
A1.F.IF.C.9a	Compare properties of two different functions. Functions may be of different types and/or represented in different ways.*	**Unit 4, Lessons** 3, 12, 20 **Unit 5, Lesson** 18
A1.F.IF.C.9b	Compare properties of the same function on two different intervals or represented in two different ways.*	**Unit 3, Lessons** 9, 12 **Unit 4, Lesson** 14 **Unit 5, Lesson** 3

Note: Mathematical modeling standards are denoted by the asterisk (*).

A1.F.BF	Building Functions	Lesson(s)
A1.F.BF.A	**Build a function that models a relationship between two quantities.**	
A1.F.BF.A.1	Build a function that describes a relationship between two quantities*	**Unit 3, Lessons** 5, 14, 17, 22 **Unit 4, Lessons** 4, 6, 8–10, 12 **Unit 5, Lessons** 5, 7, 8, 23
A1.F.BF.A.1a	Determine steps for calculation, a recursive process, or an explicit expression, from a context.*	**Unit 3, Lessons** 5, 17 **Unit 4, Lessons** 5, 16–19 **Unit 5, Lessons** 2–9, 23
A1.F.BF.B	**Build new functions from existing functions.**	
A1.F.BF.B.2	Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $k\,f(x)$, $f(kx)$, and $f(x + k)$ for specific values of k (both positive and negative); find the value of k given the graphs.	**Unit 3, Lessons** 15, 17 **Unit 5, Lessons** 16, 17, 21, 22

A1.F.LE	Linear and Exponential Models*	Lesson(s)
A1.F.LE.A	**Construct and compare linear, quadratic, and exponential models and solve problems.**	
A1.F.LE.A.1	Distinguish between situations that can be modeled with linear functions and with exponential functions.*	**Unit 4, Lessons** 1–6, 12, 22 **Unit 5, Lessons** 1, 2, 5
A1.F.LE.A.1a	Know that linear functions grow by equal differences over equal intervals and that exponential functions grow by equal factors over equal intervals.*	**Unit 4, Lessons** 6, 21 **Unit 5, Lesson** 2
A1.F.LE.A.1b	Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.*	**Unit 4, Lessons** 2, 3, 5
A1.F.LE.A.1c	Recognize situations in which a quantity grows or decays by a constant factor per unit interval relative to another.*	**Unit 4, Lessons** 2–6
A1.F.LE.A.2	Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or input-output pairs.*	**Unit 4, Lessons** 4–6, 8–14, 17, 18, 20, 22 **Unit 5, Lesson** 16
A1.F.LE.B	**Interpret expressions for functions in terms of the situation they model.**	
A1.F.LE.B.3	Interpret the parameters in a linear or exponential function in terms of a context.*	**Unit 4, Lessons** 4–9, 11, 13, 17, 19

Tennessee Mathematics Standards, Algebra 1

Note: Mathematical modeling standards are denoted by the asterisk (*).

A1.S.ID	Interpreting Categorical and Quantitative Data*	Lesson(s)
A1.S.ID.A	**Summarize, represent, and interpret data on a single count or measurement variable.**	
A1.S.ID.A.1	Use measures of center to solve real-world and mathematical problems.*	**Unit 2, Lessons** 4, 5
A1.S.ID.A.2	Use statistics appropriate to the shape of the data distribution to compare center (median, mean, and/or mode) and spread (range, interquartile range) of two or more different data sets.*	**Unit 2, Lessons** 4–6, 22
A1.S.ID.A.3	Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points.*	**Unit 2, Lesson** 5
A1.S.ID.B	**Summarize, represent, and interpret data on two categorical and quantitative variables.**	
A1.S.ID.B.4	Represent data from two quantitative variables on a scatter plot, and describe how the variables are related. Fit a function to the data; use functions fitted to data to solve problems in the context of the data.*	**Unit 2, Lessons** 11–14, 19–22 **Unit 4, Lesson** 22
A1.S.ID.C	**Interpret linear models.**	
A1.S.ID.C.5	Interpret the rate of change and the constant term of a linear model in the context of the data.*	**Unit 2, Lessons** 12, 22
A1.S.ID.C.6	Use technology to compute the correlation coefficient of a linear model; interpret the correlation coefficient in the context of the data.*	**Unit 2, Lessons** 19, 20, 22
A1.S.ID.C.7	Explain the differences between correlation and causation. Recognize situations where an additional factor may be affecting correlated data.*	**Unit 2, Lessons** 21, 22

Standards for Mathematical Practice

MP1 Make sense of problems and persevere in solving them.

Mathematically proficient students start by explaining to themselves the meaning of a problem and looking for entry points to its solution. They analyze givens, constraints, relationships, and goals. They make conjectures about the form and meaning of the solution and plan a solution pathway rather than simply jumping into a solution attempt. They consider analogous problems and try special cases and simpler forms of the original problem in order to gain insight into its solution. They monitor and evaluate their progress and change course if necessary. Older students might, depending on the context of the problem, transform algebraic expressions or change the viewing window on their graphing calculator to get the information they need. Mathematically proficient students can explain correspondences between equations, verbal descriptions, tables, and graphs or draw diagrams of important features and relationships, graph data, and search for regularity or trends. Younger students might rely on using concrete objects or pictures to help conceptualize and solve a problem. Mathematically proficient students check their answers to problems using a different method, and they continually ask themselves, "Does this make sense?" They can understand the approaches of others to solving complex problems and identify correspondences between different approaches.

Unit 1, Lessons 1, 6, 7, 10, 11, 12A, 13, 20, 26

Unit 2, Lesson 18

Unit 3, Lesson 12

Unit 5, Lesson 5

Unit 6, Lessons 1–3, 9, 10, 12, 14, 18, 19, 22

MP2 Reason abstractly and quantitatively.

Mathematically proficient students make sense of quantities and their relationships in problem situations. They bring two complementary abilities to bear on problems involving quantitative relationships: the ability to decontextualize — to abstract a given situation and represent it symbolically and manipulate the representing symbols as if they have a life of their own, without necessarily attending to their referents — and the ability to contextualize, to pause as needed during the manipulation process in order to probe into the referents for the symbols involved. Quantitative reasoning entails habits of creating a coherent representation of the problem at hand, considering the units involved, attending to the meaning of quantities, not just how to compute them, and knowing and flexibly using different properties of operations and objects.

Unit 1, Lessons 1, 3–5, 11, 12, 12A, 12C, 13–15, 17, 22–25

Unit 2, Lessons 1, 2, 4, 5, 12

Unit 3, Lessons 3–7, 9–12, 14, 15

Unit 4, Lessons 4, 6, 9, 11, 14, 20

Unit 5, Lessons 2, 4, 5, 15, 18, 19, 22, 23

Unit 6, Lessons 1–4, 15A, 21, 22, 24

MP3 Construct viable arguments and critique the reasoning of others.

Mathematically proficient students understand and use stated assumptions, definitions, and previously established results in constructing arguments. They make conjectures and build a logical progression of statements to explore the truth of their conjectures. They are able to analyze situations by breaking them into cases and can recognize and use counterexamples. They justify their conclusions, communicate them to others, and respond to the arguments of others. They reason inductively about data, making plausible arguments that take into account the context from which the data arose. Mathematically proficient students are also able to compare the effectiveness of two plausible arguments, distinguish correct logic or reasoning from that which is flawed, and, if there is a flaw in an argument, explain what it is. Elementary students can construct arguments using concrete referents such as objects, drawings, diagrams, and actions. Such arguments can make sense and be correct, even though they are not generalized or made formal until later grades. Later, students learn to determine domains to which an argument applies. Students at all grades can listen or read the arguments of others, decide whether they make sense, and ask useful questions to clarify or improve the arguments.

Unit 1, Lessons 3, 8, 17A, 21

Unit 2, Lessons 3, 11, 13, 14, 19–22

Unit 3, Lessons 2, 4, 9, 14

Unit 4, Lessons 11, 15, 17, 20

Unit 5, Lessons 3, 5, 6, 11A, 16, 21

Unit 6, Lessons 5, 6, 13, 15, 20, 21, 24

Standards for Mathematical Practice

MP4 Model with mathematics.

Mathematically proficient students can apply the mathematics they know to solve problems arising in everyday life, society, and the workplace. In early grades, this might be as simple as writing an addition equation to describe a situation. In middle grades, a student might apply proportional reasoning to plan a school event or analyze a problem in the community. By high school, a student might use geometry to solve a design problem or use a function to describe how one quantity of interest depends on another. Mathematically proficient students who can apply what they know are comfortable making assumptions and approximations to simplify a complicated situation, realizing that these may need revision later. They are able to identify important quantities in a practical situation and map their relationships using such tools as diagrams, two-way tables, graphs, flowcharts, and formulas. They can analyze those relationships mathematically to draw conclusions. They routinely interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose.

Unit 1, Lessons 5, 6, 10, 11, 13, 15–17, 22, 24–26

Unit 2, Lessons 2, 4, 12, 21

Unit 3, Lessons 1, 2, 13, 15, 17, 22

Unit 4, Lessons 1–3, 6, 8–20, 22

Unit 5, Lessons 1, 7, 9, 15, 22, 23

Unit 6, Lessons 1, 4, 12, 15A, 22

Please also see the Mathematical Modeling Prompts 1–9 as part of Additional Practice provided for Algebra 1.

MP5 Use appropriate tools strategically.

Mathematically proficient students consider the available tools when solving a mathematical problem. These tools might include pencil and paper, concrete models, a ruler, a compass, a protractor, a calculator, a spreadsheet, a computer algebra system, a statistical package, or dynamic geometry software. Proficient students are sufficiently familiar with tools appropriate for their grade or course to make sound decisions about when each of these tools might be helpful, recognizing both the insight to be gained and their limitations. For example, mathematically proficient high school students analyze graphs of functions and solutions generated using a graphing calculator. They detect possible errors by strategically using estimation and other mathematical knowledge. When making mathematical models, they know that technology can enable them to visualize the results of varying assumptions, explore consequences, and compare predictions with data. Mathematically proficient students at various grade levels are able to identify relevant external mathematical resources, such as digital content located on a website, and use them to pose or solve problems. They are able to use technological tools to explore and deepen their understanding of concepts.

Unit 1, Lessons 6, 10, 17, 19, 20

Unit 2, Lessons 6, 20, 22

Unit 4, Lessons 1, 4, 6, 12, 20

Unit 5, Lessons 6, 8, 11

Unit 6, Lessons 3, 5, 16, 21

MP6 Attend to precision.

Mathematically proficient students try to communicate precisely to others. They try to use clear definitions in discussion with others and in their own reasoning. They state the meaning of the symbols they choose, including using the equal sign consistently and appropriately. They are careful about specifying units of measure and labeling axes to clarify the correspondence with quantities in a problem. They calculate accurately and efficiently, expressing numerical answers with a degree of precision appropriate for the problem context. In the elementary grades, students give carefully formulated explanations to each other. By the time they reach high school, they have learned to examine claims and make explicit use of definitions.

Unit 1, Lessons 2, 6, 8, 11, 12A, 12B, 18, 23

Unit 2, Lessons 1, 3, 5, 6, 12, 14, 19

Unit 3, Lessons 3, 4, 6–8, 10–17, 22

Unit 4, Lessons 2, 7, 10, 12, 19

Unit 5, Lessons 9, 11, 18, 20, 21

Unit 6, Lessons 9, 10, 12–14, 16, 18, 20, 21

MP7 Look for and make use of structure.

Mathematically proficient students look closely to discern a pattern or structure. Young students, for example, might notice that three and seven more is the same amount as seven and three more, or they may sort a collection of shapes according to how many sides the shapes have. Later, students see 7×8 equals the well-remembered $7 \times 5 + 7 \times 3$, in preparation for learning about the distributive property. In the expression $x^2 + 9x + 14$, older students can see the 14 as 2×7 and the 9 as $2 + 7$. They recognize the significance of an existing line in a geometric figure and can use the strategy of drawing an auxiliary line for solving problems. They also can step back for an overview and shift perspective. They can see complicated things, such as some algebraic expressions, as single objects or as being composed of several objects. For example, they can see $5 - 3(x - y)^2$ as 5 minus a positive number times a square and use that to realize that its value cannot be more than 5 for any real numbers x and y.

Unit 1, Lessons 3, 7, 9, 11, 12, 12B, 14, 18, 19, 22

Unit 2, Lessons 2, 5, 13, 18

Unit 3, Lessons 3, 5, 16, 17

Unit 4, Lessons 2, 5, 12, 13, 15, 18, 19, 21

Unit 5, Lessons 2–7, 10–22

Unit 6, Lessons 3–5, 7–15, 18, 20, 22, 24

MP8 Look for and express regularity in repeated reasoning.

Mathematically proficient students notice if calculations are repeated and look both for general methods and for shortcuts. Upper elementary students might notice when dividing 25 by 11 that they are repeating the same calculations over and over again, and conclude they have a repeating decimal. By paying attention to the calculation of slope as they repeatedly check whether points are on the line through $(1, 2)$ with slope 3, middle school students might abstract the equation $\frac{(y-2)}{(x-1)} = 3$. Noticing the regularity in the way terms cancel when expanding $(x-1)(x+1)$, $(x-1)(x^2+x+1)$, and $(x-1)(x^3+x^2+x+1)$ might lead them to the general formula for the sum of a geometric series. As they work to solve a problem, mathematically proficient students maintain oversight of the process, while attending to the details. They continually evaluate the reasonableness of their intermediate results.

Unit 1, Lessons 2, 8, 9, 14, 15

Unit 4, Lessons 4, 5, 14, 16

Unit 5, Lessons 3, 4, 7, 8, 11A, 17, 21

Unit 6, Lessons 3, 6, 7, 8, 11, 14, 15, 19, 24

Practice Problem Analysis

Teachers may omit the following Practice Problems from the indicated lessons as they address topics beyond the scope of the Tennessee Mathematics Standards.

Unit 2: Data Analysis and Statistics

Lesson	Problem(s)
6	5
11	4
13	4, 5
14	5
20	3
21	4
22	1, 2

Unit 3: Functions and Their Graphs

Lesson	Problem(s)
1	3
2	5
17	6
22	3, 4, 5

Unit 6: Quadratic Equations

Lesson	Problem(s)
1	4, 5
16	5
18	4

Compound Linear Inequalities

Let's explore the solutions of two inequalities joined together.

Focus

Goals

1. Interpret the solution to a compound inequality as the set of values that satisfies all parts of the statement.
2. Recognize the inequalities that are represented by a solution given on a number line.
3. **Language Goal:** Explain how to write a compound inequality to represent a real-world situation. **(Speaking and Listening)**

Coherence

Today

Students revisit graphing simple inequalities and are introduced to compound inequalities. Students reason abstractly and quantitatively as they write and solve a compound inequality to analyze a situation in context, and see that the same solution set can be represented by different compound inequalities **(MP2)**.

Previously

In Lesson 12, students activated prior knowledge of solutions to inequalities. They wrote inequalities in one variable and solved problems to make sense of solution sets of inequalities in context.

Coming Soon

In Tennessee Lesson 12B, students will solve absolute value equations in one variable.

Rigor

- Students build **conceptual understanding** of compound inequalities.
- Students develop **procedural skills** solving and graphing inequalities.

Standards

Addressing

A1.A.REI.B.2a

Solve linear equations and inequalities, including compound inequalities, in one variable. Represent solutions algebraically and graphically.

Pacing Guide

Suggested Total Lesson Time ~**50 min**

Warm-up	Activity 1	Activity 2	Activity 3	Summary	Exit Ticket
5 min	8 min	12 min	15 min	5 min	5 min
Independent	Pairs	Pairs	Pairs	Whole Class	Independent
MP2		MP1, MP2	MP6		
A1.A.REI.B.2a	A1.A.REI.B.2a	A1.A.REI.B.2a	A1.A.REI.B.2a	A1.A.REI.B.2a	A1.A.REI.B.2a

Amps powered by desmos | Activity and Presentation Slides

For a digitally interactive experience of this lesson, log in to Amplify Math at **learning.amplify.com**.

Practice Independent

Materials

- Exit Ticket
- Additional Practice
- Activity 3 PDF, pre-cut cards, one set per pair

Math Language Development

New words

- *compound inequality*

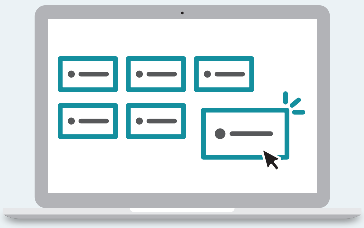
Review words

- *inequality*
- *solution*

Amps | Featured Activity

Activity 3
Digital Card Sort

Save time by having students use the digital card sort. Address class-wide misconceptions quickly by scanning student work and identifying common areas of confusion.



Amps POWERED BY desmos

Building Math Identity and Community

Connecting to Mathematical Practices

Students who feel more confident with reasoning abstractly and quantitatively may be able to lead discussions with their partner in Activity 2 **(MP2)**. Remind students to "step up" if they have something to add to the conversation, but to "step back" to give other voices a chance to share.

Modifications to Pacing

You may want to consider this additional modification if you are short on time.

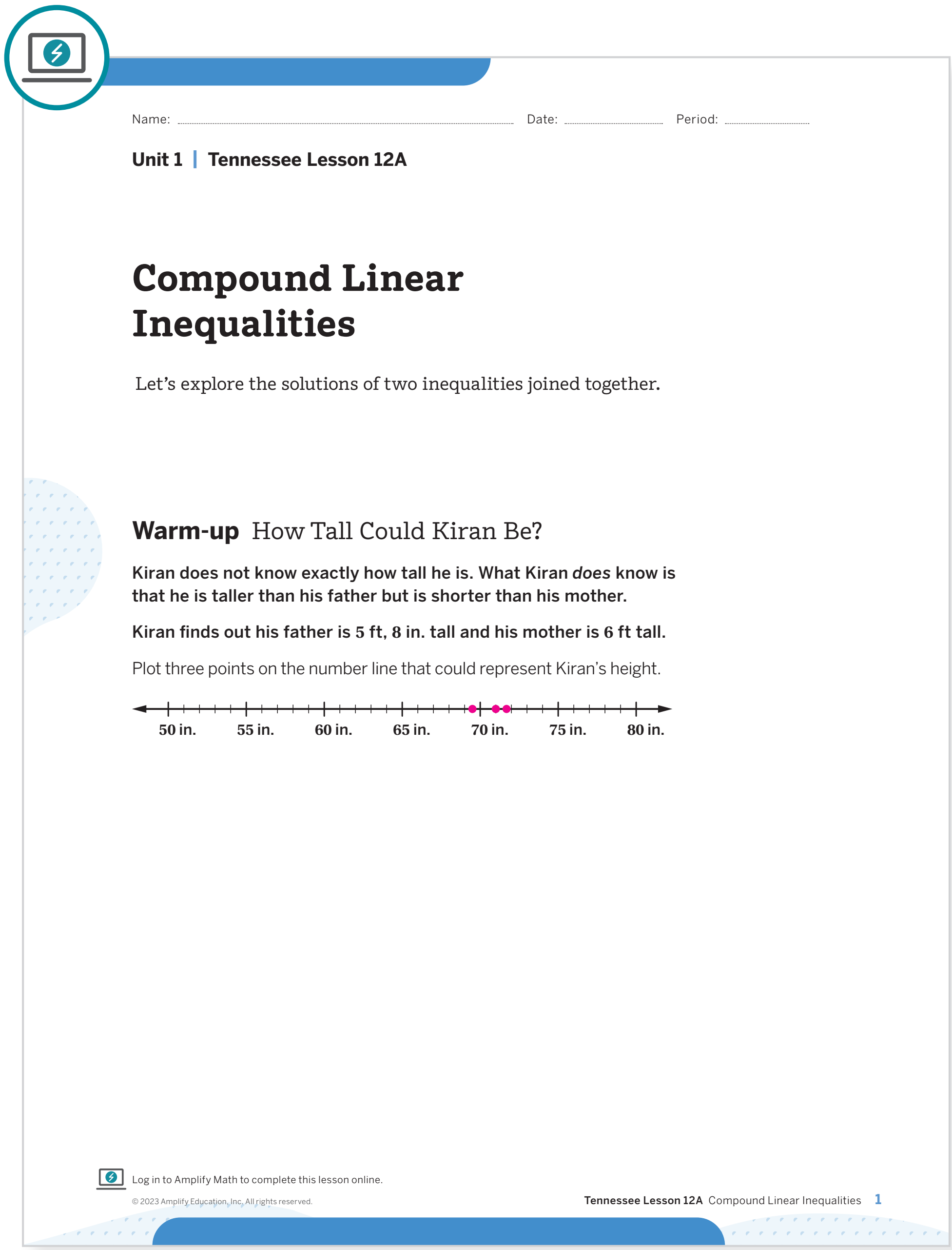
- In **Activity 1**, omit Problems 2 and 3.
- In **Activity 3**, have students choose one problem to complete.

Independent | 5 min

Warm-up How Tall Could Kiran Be?

MP2
A1.A.REI.B.2a

Students graph possible heights, with restrictions, on a number line to learn about a compound inequality.



Name: ____________ Date: ________ Period: ________

Unit 1 | Tennessee Lesson 12A

Compound Linear Inequalities

Let's explore the solutions of two inequalities joined together.

Warm-up How Tall Could Kiran Be?

Kiran does not know exactly how tall he is. What Kiran *does* know is that he is taller than his father but is shorter than his mother.

Kiran finds out his father is 5 ft, 8 in. tall and his mother is 6 ft tall.

Plot three points on the number line that could represent Kiran's height.

Log in to Amplify Math to complete this lesson online.

Tennessee Lesson 12A Compound Linear Inequalities 1

1 Launch

Read the introduction as a class before instructing students to mark their number lines independently.

2 Monitor

Help students get started by reminding students there are 12 in. in 1 ft.

Look for points of confusion:

- **Marking exactly 68 or 72 in. on the number line.** Ask, "Does it say that Kiran could be exactly as tall as his father or mother?"

Look for productive strategies:

- Marking non-whole number values on the number line.

3 Connect

Display the number line.

Have students share the points they marked. As they do so, add the points to the line for the class to see.

Ask:

- "If we marked *all* of the possible heights Kiran could be on the number line, what would that look like?"
- "How can we show that 68 in. or 72 in. should not be marked on the number line?"

Highlight that students can represent all of Kiran's possible heights using comparison symbols, such as <, >, ≤, and ≥. In this way, Kiran's height x can be represented as $68 < x < 72$ or $68 < x$ and $x < 72$ **(MP2)**.

Define ***compound inequality*** as an inequality statement that joins two inequalities together.

Differentiated Support

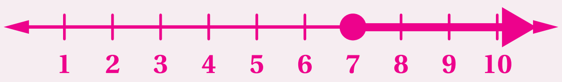
Accessibility: ***Guide Processing and Visualization***

Suggest that students sketch a diagram of Kiran and his parents. Ask, "How does your diagram relate to the number line from our class data?"

Power-up

To power up students' ability to determine the solution set of an inequality in one variable, have students complete:

Graph the solution to the inequality $x \geq 7$ on a number line.



Use: Before the Warm-up

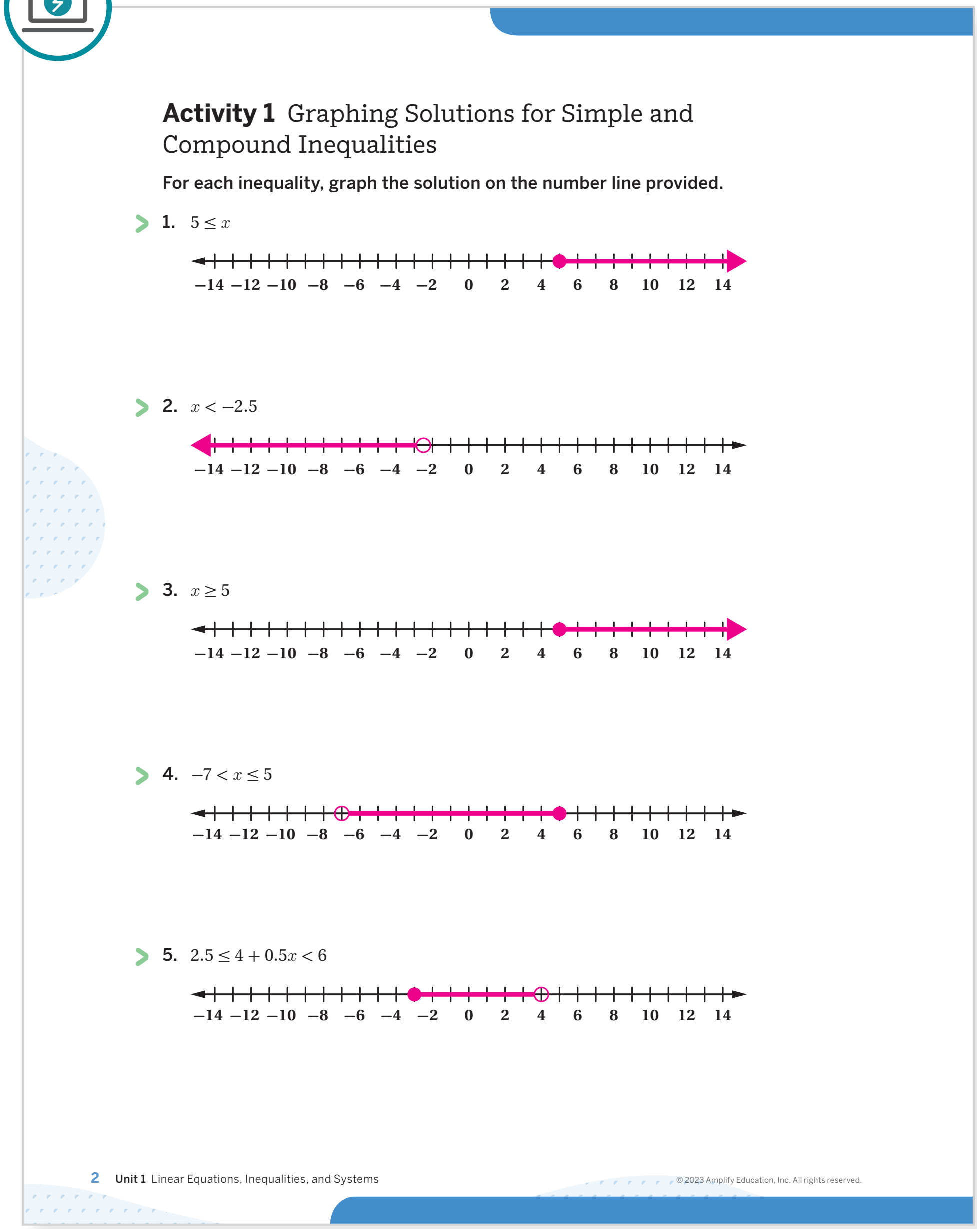
Informed by: Performance on Lesson 12, Practice Problem 6

Activity 1 Graphing Solutions for Simple and Compound Inequalities

Pairs | 8 min

A1.A.REI.B.2a

Students revisit graphing simple inequalities to extend their understanding of graphing compound inequalities.



Activity 1 Graphing Solutions for Simple and Compound Inequalities

For each inequality, graph the solution on the number line provided.

1. $5 \le x$

2. $x < -2.5$

3. $x \ge 5$

4. $-7 < x \le 5$

5. $2.5 \le 4 + 0.5x < 6$

2 **Unit 1** Linear Equations, Inequalities, and Systems

1 Launch

Activate prior knowledge by asking, "What is the difference between the comparison symbols $<$ and $\le$?"

2 Monitor

Help students get started by suggesting that they first consider whether they will need to use an open or a closed circle at the boundary value.

Look for points of confusion:

- **Shading the wrong direction.** Have students read the inequality statement aloud.
- **In Problem 4, shading the entire line, treating it as an *or* statement.** Say, "x must be both greater than -7 *and* less than or equal to 5. Is your shaded value 10 true for both?"
- **Not knowing where to start in Problem 5.** Suggest to consider the statement in two pieces, $2.5 \le 4 + 0.5x$ *and* $4 + 0.5x \le 6$ and then solve each inequality.

Look for productive strategies:

- Noticing the graphs in Problems 1 and 3 have the same solution. Realizing that, for Problem 5, the values shown are not the boundary values.

3 Connect

Display the solutions for Problems 1–4 and ask whether any students disagree or have questions. Then display Problem 5 and have students share their solutions.

Highlight that, when a compound inequality contains an expression, students will need to set up two inequalities and then solve each one separately. Then they must consider how the solution must be true for both inequalities in a statement such as in Problem 5.

Ask:

- "Why do Problems 4 and 5 not contain a shaded arrow?"
- "How can you check that one or a few of your solutions are valid for Problem 5?"

Differentiated Support

Accessibility: *Vary Demands to Optimize Challenge*

If students need more processing time, have students focus on completing Problems 1, 2, and 5.

Accessibility: *Clarify Vocabulary and Symbols*

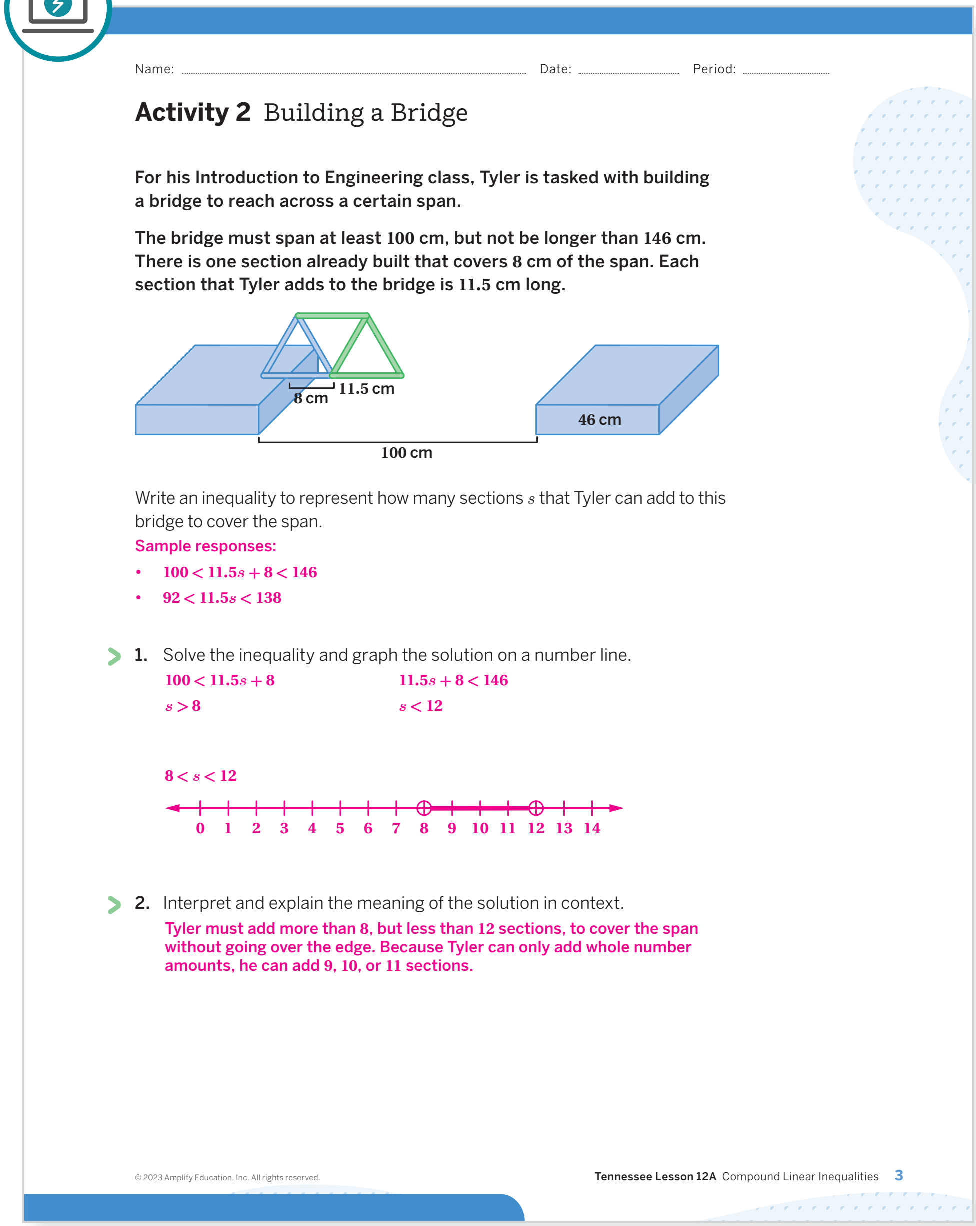
Maintain a display of the inequality comparison symbols and their meanings.

Pairs | 12 min

Activity 2 Building a Bridge

MP1, MP2
A1.A.REI.B.2a

Students analyze a situation in context to write and solve a compound inequality **(MP1, MP2).**



Name: ______________ Date: ______________ Period: ______________

Activity 2 Building a Bridge

For his Introduction to Engineering class, Tyler is tasked with building a bridge to reach across a certain span.

The bridge must span at least 100 cm, but not be longer than 146 cm. There is one section already built that covers 8 cm of the span. Each section that Tyler adds to the bridge is 11.5 cm long.

Write an inequality to represent how many sections s that Tyler can add to this bridge to cover the span.

Sample responses:

- $100 < 11.5s + 8 < 146$
- $92 < 11.5s < 138$

1. Solve the inequality and graph the solution on a number line.

$100 < 11.5s + 8$ $\quad$ $11.5s + 8 < 146$

$s > 8$ $\quad$ $s < 12$

$8 < s < 12$

2. Interpret and explain the meaning of the solution in context.

Tyler must add more than 8, but less than 12 sections, to cover the span without going over the edge. Because Tyler can only add whole number amounts, he can add 9, 10, or 11 sections.

1 Launch

Read the introduction together as a class. To check for comprehension, ask clarifying questions such as: "If Tyler adds one more section, how much longer will his bridge be? Why can the bridge not be longer than 146 cm?"

2 Monitor

Help students get started by asking, "If each section of the bridge adds 11.5 cm, how long will a 2-section bridge be? A 3-section bridge?"

Look for points of confusion:

- **Ignoring the 8 cm section at the start.** Say, "Notice that the sections Tyler is adding do not start right at the edge. How much left of the 100 cm does Tyler need to cover? How can you show that in your inequality?"
- **Writing the solution as two separate inequalities.** Though this is not incorrect, the goal is to write a compound inequality. Have students refer back to Problem 5 in Activity 1 for an example of a compound inequality written this way.

Look for productive strategies:

- Noticing there is more than one way to write the compound inequality to represent the situation.

3 Connect

Display a student's solution to Problem 1.

Have students share what each part of the compound inequality in their work represents. Then, display a second student's work with a different compound inequality to compare and contrast.

Highlight that inequalities can be rewritten in equivalent form, as with equations. However, in a compound inequality, students must consider how rewriting it will affect all parts of the inequality.

Ask, "Considering the situation, does the solution on the number line match the possible solutions to the word problem?"

Math Language Development

MLR8: Discussion Supports

During the Connect, as students share their methods for solving each problem, revoice their ideas in the form of a question using appropriate mathematical language or language from the context. For example:

If a student says . . .	Revoice their ideas by asking . . .
"Tyler can have 8 to 12 sections in his bridge."	"When you say 8 to 12, does that include 8 and 12?"

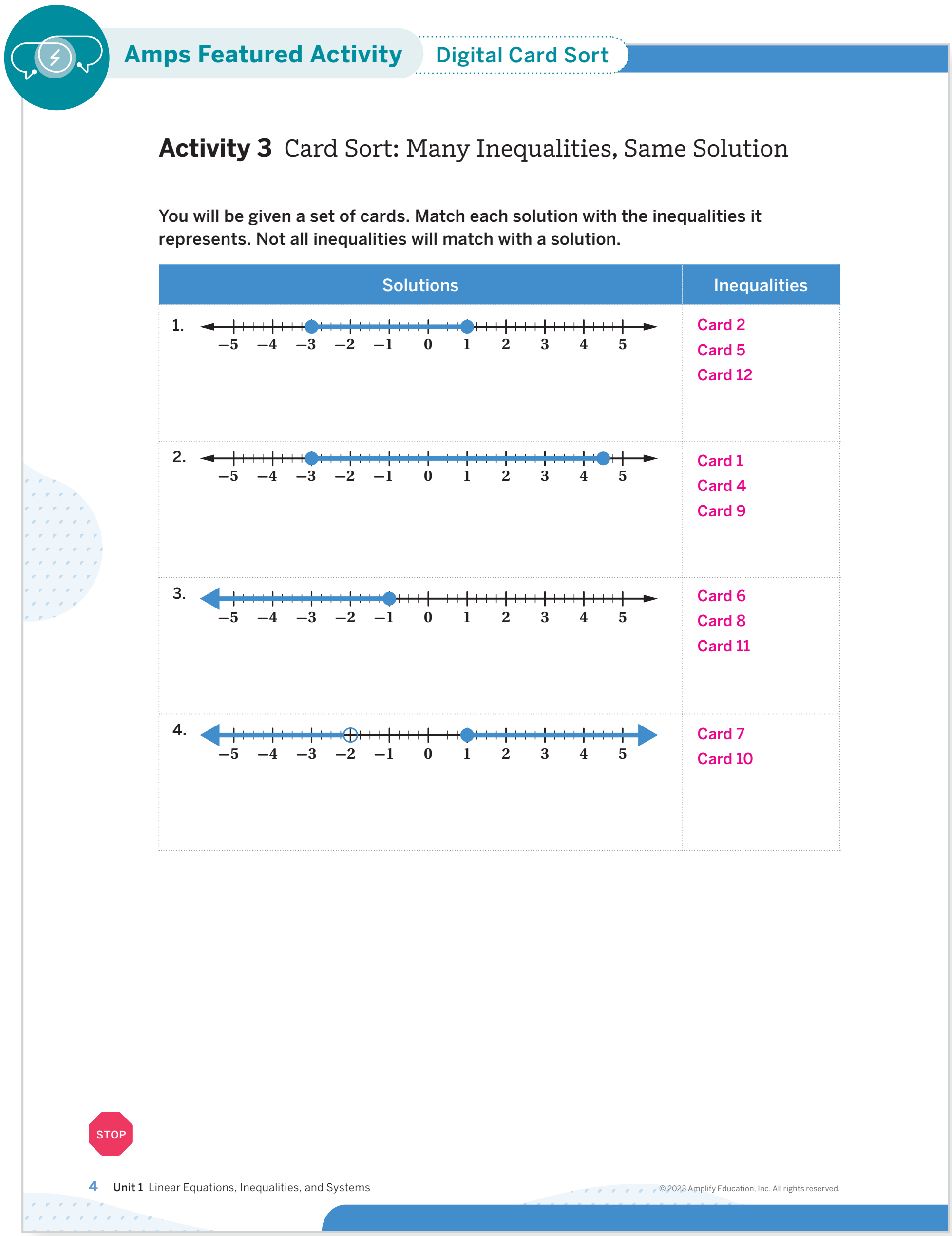
Pairs | 15 min

MP6
A1.A.REI.B.2a

Activity 3 Card Sort: Many Inequalities, Same Solution

Students match the solutions on graphs to multiple inequalities to identify equivalent inequalities **(MP6).**

Amps Featured Activity Digital Card Sort



Activity 3 Card Sort: Many Inequalities, Same Solution

You will be given a set of cards. Match each solution with the inequalities it represents. Not all inequalities will match with a solution.

Solutions	Inequalities
1.	Card 2 Card 5 Card 12
2.	Card 1 Card 4 Card 9
3.	Card 6 Card 8 Card 11
4.	Card 7 Card 10

4 **Unit 1** Linear Equations, Inequalities, and Systems

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1 Launch

Distribute one set of cards from the Activity 3 PDF to each pair of students. Tell students that not all of the inequalities will match with a solution.

2 Monitor

Help students get started by suggesting they start by matching the inequalities in which x does not have a coefficient.

Look for points of confusion:

- **Thinking that if the boundary values on the graph do not match the values at the ends of the inequality they will not be a match.** Remind students that equivalent inequalities can be written by rearranging the inequalities.
- **Thinking that the word *and* always indicates a solution that does not continue indefinitely in one direction on the number line.** Have students consider a simpler case, "$x > 1$ and $x > 2$." Ask, "What would the solution look like on a number line?"

Look for productive strategies:

- Noticing and using patterns in the multiples of the values to determine equivalent inequalities.

3 Connect

Have students share their matches and their reasoning for the matches.

Display Card 5.

Highlight that a compound inequality can be written in the same way a system of equations is written. Similar to a system of equations, the solution to a compound inequality is the set of values that satisfy both inequalities. Though students saw that most of the compound inequalities in the lesson had a solution that was a segment on the number line, remind students that this is not always the case.

Ask:

- "How does an *or* inequality differ from an *and* inequality? How are they similar?"
- "Can an *or* inequality be written to match the first graph? Third graph?"

Differentiated Support

Accessibility: *Vary Demands to Optimize Challenge*

Chunk the task into more manageable parts by having students consider only one card at a time, keeping the rest face down.

Math Language Development

MLR3: Critique, Correct, Clarify

During the Connect, display the following incorrect statement, "A compound inequality will always have two boundary values." Ask:

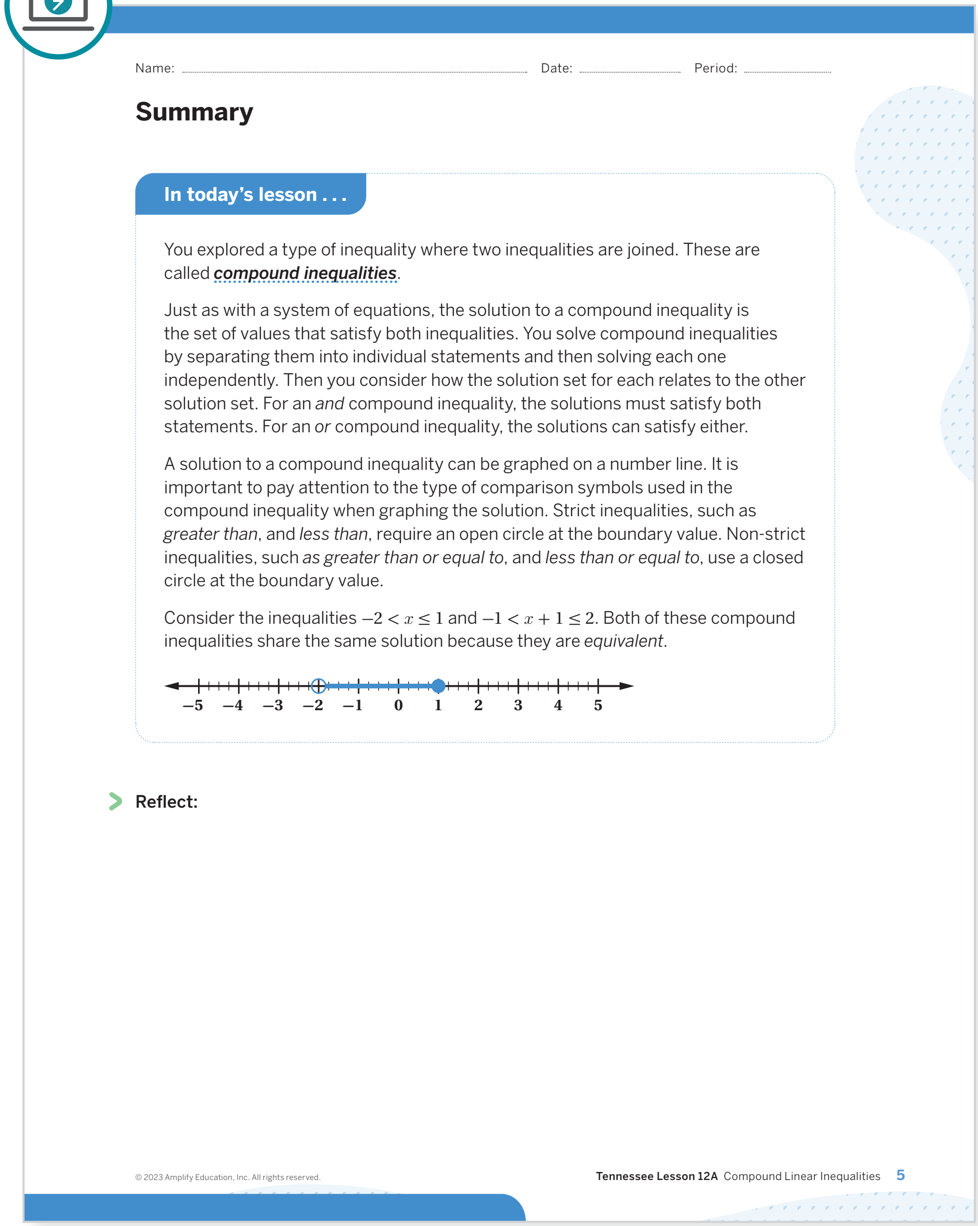
- **Critique:** "Do you agree or disagree with this statement? Why or why not?"
- **Correct:** "Write a corrected statement that is now true."
- **Clarify:** "What was the most likely misunderstanding that the person who wrote this incorrect statement had?" They did not consider that one part of the inequality might already include the entire set of solution values to the other part, as in Problem 3.

Whole Class | 5 min

Summary

A1.A.REI.B.2a

Review and synthesize how to determine and represent the solution to a compound inequality.



Name: ______ Date: ______ Period: ______

Summary

In today's lesson . . .

You explored a type of inequality where two inequalities are joined. These are called ***compound inequalities***.

Just as with a system of equations, the solution to a compound inequality is the set of values that satisfy both inequalities. You solve compound inequalities by separating them into individual statements and then solving each one independently. Then you consider how the solution set for each relates to the other solution set. For an *and* compound inequality, the solutions must satisfy both statements. For an *or* compound inequality, the solutions can satisfy either.

A solution to a compound inequality can be graphed on a number line. It is important to pay attention to the type of comparison symbols used in the compound inequality when graphing the solution. Strict inequalities, such as *greater than*, and *less than*, require an open circle at the boundary value. Non-strict inequalities, such *as greater than or equal to*, and *less than or equal to*, use a closed circle at the boundary value.

Consider the inequalities $-2 < x \leq 1$ and $-1 < x + 1 \leq 2$. Both of these compound inequalities share the same solution because they are *equivalent*.

Reflect:

Synthesize

Have students share their favorite tips for solving inequalities.

Highlight that when representing the solution to a compound inequality on a number line, students can graph both solutions separately and check for where the graphs overlap. This overlap represents where both inequality statements are true. For an *or* inequality, the graphs are true where either solution exists.

Formalize vocabulary: *compound inequality*

Reflect

After synthesizing the concepts of the lesson, allow students a few moments for reflection. Encourage them to record any notes in the *Reflect* space provided in the Student Edition. To help them engage in meaningful reflection, consider asking:

- "How is solving a compound inequality similar to or different from solving a system of equations?"

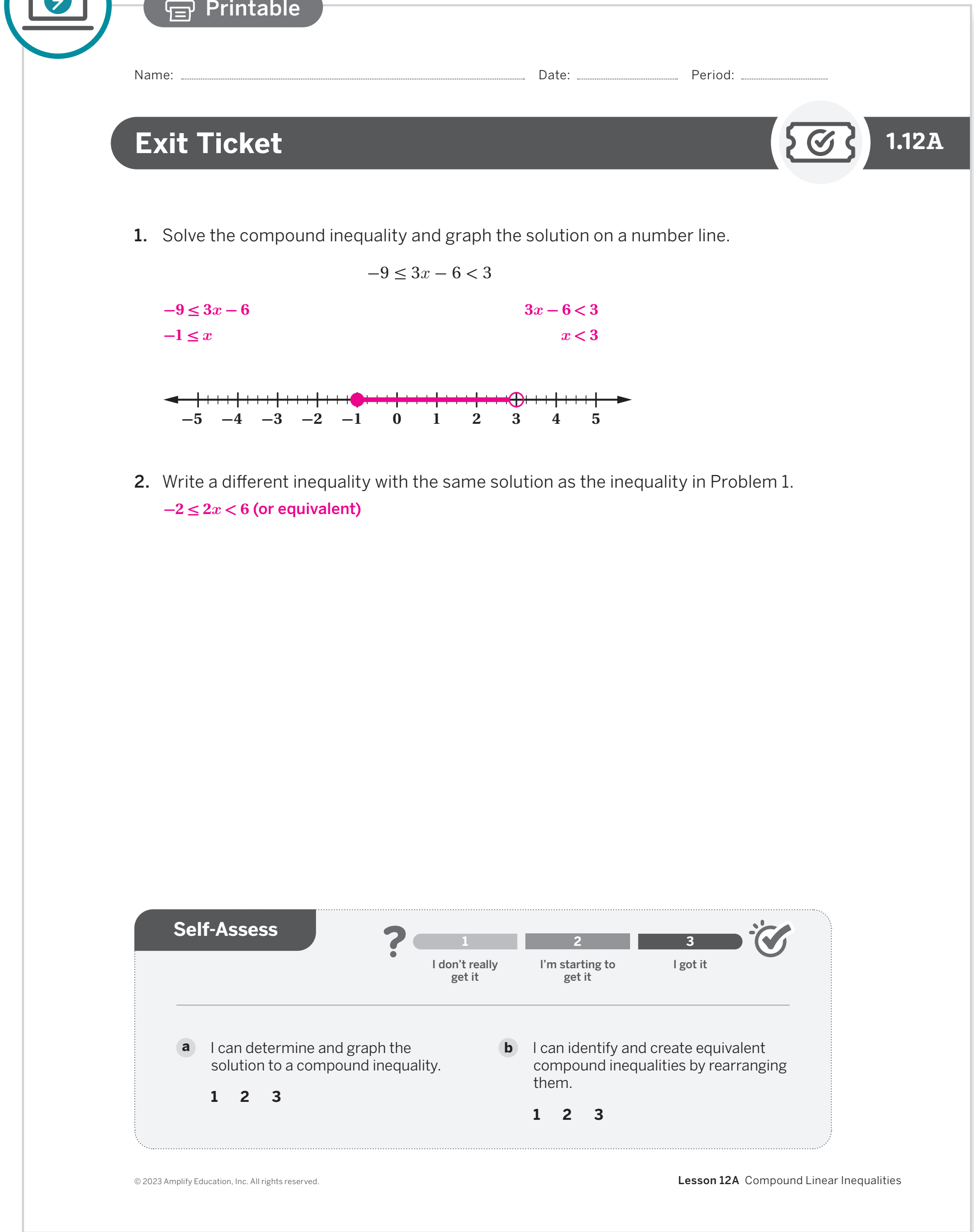
Independent | 5 min

Exit Ticket

A1.A.REI.B.2a

Students demonstrate their understanding of compound inequalities by determining the solution, graphing the solution, and rearranging it into an equivalent compound inequality.

Printable



Name: ______________________ Date: __________ Period: __________

Exit Ticket

1.12A

1. Solve the compound inequality and graph the solution on a number line.

$$-9 \le 3x - 6 < 3$$

$-9 \le 3x - 6$ $\quad$ $3x - 6 < 3$

$-1 \le x$ $\quad$ $x < 3$

2. Write a different inequality with the same solution as the inequality in Problem 1.

$-2 \le 2x < 6$ (or equivalent)

Self-Assess

? 1 I don't really get it | 2 I'm starting to get it | 3 I got it

a I can determine and graph the solution to a compound inequality.

1 2 3

b I can identify and create equivalent compound inequalities by rearranging them.

1 2 3

Success looks like . . .

- **Goal:** Interpreting the solution to a compound inequality as the set of values that satisfies all parts of the statement.
  - » Representing the appropriate set of values on the number line in Problem 1.
- **Goal:** Recognizing the inequalities that are represented by a solution given on a number line.
  - » Translating the inequality from Problem 1 into an equivalent inequality in Problem 2.
- **Language Goal:** Explaining how to write a compound inequality to represent a real-world situation. **(Speaking and Listening)**

Suggested next steps

If students make a computational error while solving the inequality, consider:

- Reviewing whether they set up the solution properly first. If yes, give them an opportunity to identify the error in their solution.

If students correctly solve the inequality, but represent the solution incorrectly on the graph, consider:

- Reviewing Activity 1
- Assigning Practice Problem 1

Professional Learning

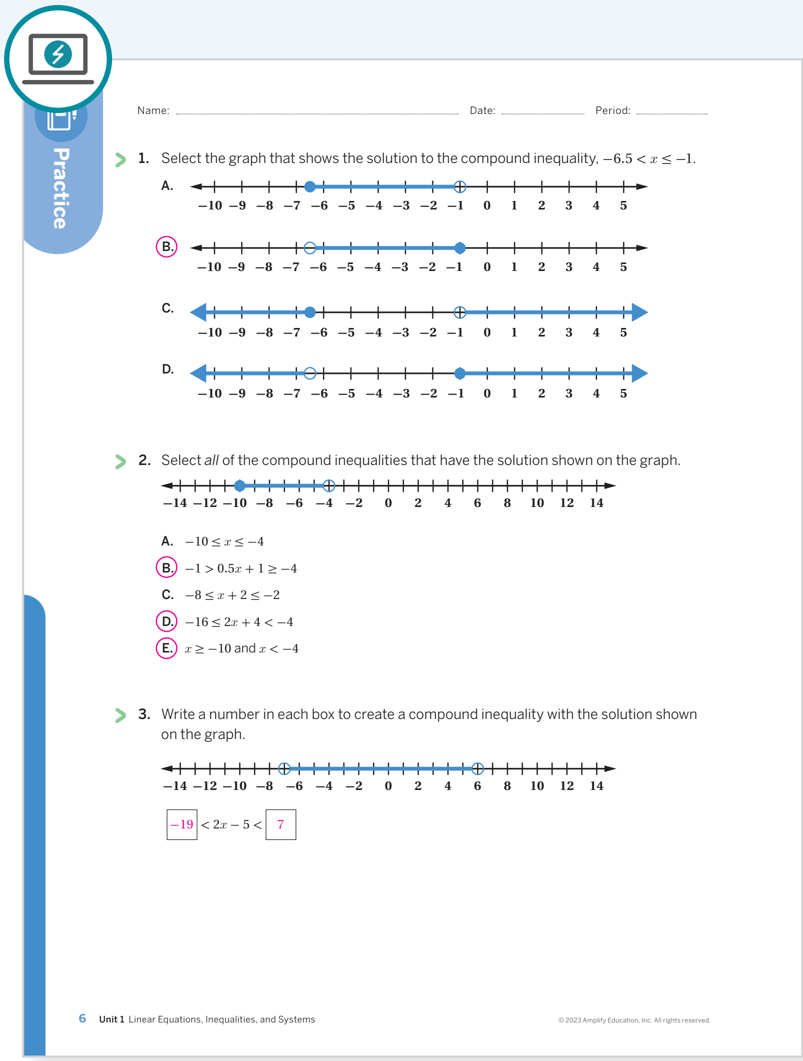
This professional learning moment is designed to be completed independently or collaboratively with your fellow mathematics educators. Prompts are provided so that you can reflect on this lesson before moving on to the next lesson.

Points to Ponder . . .

- What worked and didn't work today? During the discussion during Activity 1, how did you encourage each student to listen to one another's strategies?
- What routines enabled all students to do math in today's lesson? What might you change for the next time you teach this lesson?

Practice

Independent



Name: Date: Period:

Practice

1. Select the graph that shows the solution to the compound inequality, $-6.5 < x \leq -1$.

A.

[✓ B.]

C.

D.

2. Select *all* of the compound inequalities that have the solution shown on the graph.

A. $-10 \leq x \leq -4$

[✓ B.] $-1 > 0.5x + 1 \geq -4$

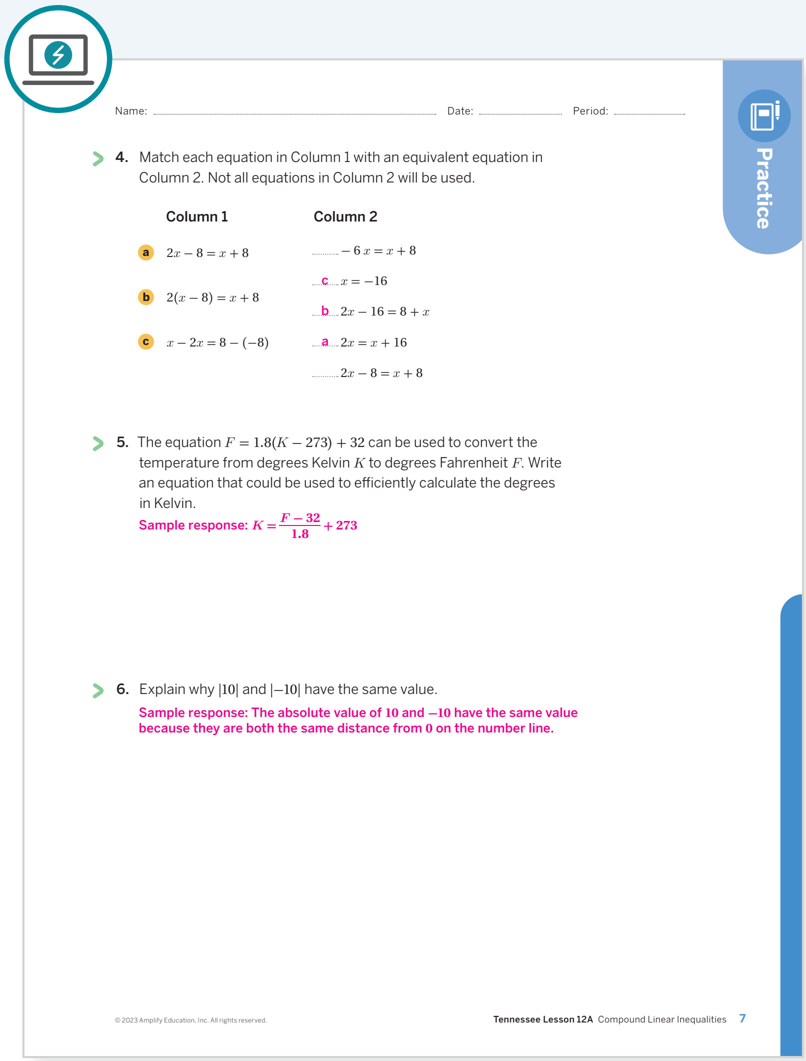
C. $-8 \leq x + 2 \leq -2$

[✓ D.] $-16 \leq 2x + 4 < -4$

[✓ E.] $x \geq -10$ and $x < -4$

3. Write a number in each box to create a compound inequality with the solution shown on the graph.

$\boxed{-19} < 2x - 5 < \boxed{7}$



Name: Date: Period:

Practice

4. Match each equation in Column 1 with an equivalent equation in Column 2. Not all equations in Column 2 will be used.

Column 1	Column 2
a $2x - 8 = x + 8$	..... $-6x = x + 8$
	c $x = -16$
b $2(x - 8) = x + 8$	b $2x - 16 = 8 + x$
c $x - 2x = 8 - (-8)$	a $2x = x + 16$
	..... $2x - 8 = x + 8$

5. The equation $F = 1.8(K - 273) + 32$ can be used to convert the temperature from degrees Kelvin K to degrees Fahrenheit F. Write an equation that could be used to efficiently calculate the degrees in Kelvin.

Sample response: $K = \frac{F - 32}{1.8} + 273$

6. Explain why $|10|$ and $|-10|$ have the same value.

Sample response: The absolute value of 10 and −10 have the same value because they are both the same distance from 0 on the number line.

Practice Problem Analysis

Type	Problem	Refer to	Standard(s)	DOK
On-lesson	1	Activity 1	A1.A.REI.B.2a	1
	2	Activity 3	A1.A.REI.B.2a	2
	3	Activity 3	A1.A.REI.B.2a	2
Spiral	4	Unit 1 Lesson 10	A1.A.CED.A.4	2
	5	Unit 1 Lesson 10	A1.A.CED.A.4	2
Formative	6	Unit 1 Tennessee Lesson 12B	6.NS.C.7	2

Power-up: If students need additional support with the key prerequisite concept or skill this problem addresses, consider assigning the Power-up in the next lesson.

Additional Practice Available

For students who need additional practice in this lesson, assign the **Algebra 1 Additional Practice**.

Absolute Value Equations

Let’s solve equations involving absolute value.

Focus

Goal

1. **Language Goal:** Determine the solutions of absolute value equations in one variable. **(Reading and Writing)**

Coherence

Today

Students activate their prior knowledge about *absolute value* to make sense of the meaning of an absolute value equation. They look for and make use of structure in an algebraic approach and in a graphical approach for determining the solutions of an absolute value equation **(MP7)**. They then apply the strategy of their choosing to practice solving absolute value equations.

Previously

In Tennessee Lesson 12A, students determined the union and intersection of intervals by solving and graphing compound inequalities in one variable.

Coming Soon

In Tennessee Lesson 12C, students will solve absolute value inequalities in one variable.

Rigor

- Students develop a **conceptual understanding** of absolute value equations and how to represent them on a number line.
- Students build **fluency** by solving equations and evaluating absolute value expressions for a given value.

Standards

Addressing

A1.A.REI.B.2b
Solve absolute value equations and inequalities **in one variable. Represent solutions algebraically and graphically.**

Pacing Guide

Suggested Total Lesson Time ~**50 min**

Warm-up	Activity 1	Activity 2	Summary	Exit Ticket
10 min	10 min	20 min	5 min	5 min
Independent	Pairs	Pairs	Whole Class	Independent
MP6	MP7			
A1.A.REI.B.2b	A1.A.REI.B.2b	A1.A.REI.B.2b	A1.A.REI.B.2b	A1.A.REI.B.2b

Amps powered by desmos | Activity and Presentation Slides

For a digitally interactive experience of this lesson, log in to Amplify Math at **learning.amplify.com**.

Practice Independent

Materials

- Exit Ticket
- Additional Practice
- Anchor Chart PDF, *Absolute Value*
- Anchor Chart PDF, *Two Ways to Solve Absolute Value Equations*
- chair

Math Language Development

Review words

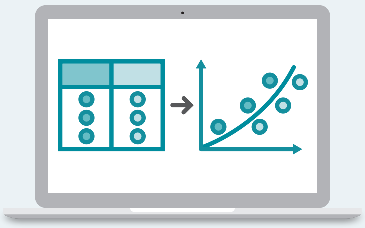
- *absolute value*

Amps | Featured Activity

Activity 1

Two Ways to Solve Absolute Value Equations

Students examine and compare two different strategies for solving absolute value equations, then decide which strategy they prefer. They then solve subsequent absolute value equations using the strategy they chose.



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Building Math Identity and Community

Connecting to Mathematical Practices

Students may feel overwhelmed or be undecided about which strategy to choose and apply in Activity 2 when solving absolute value equations **(MP7)**. Help them practice taking control of their own impulses by suggesting they try both methods to determine which makes more sense to them and then check in with their peers for the strategies they are using and why they chose them.

Modifications to Pacing

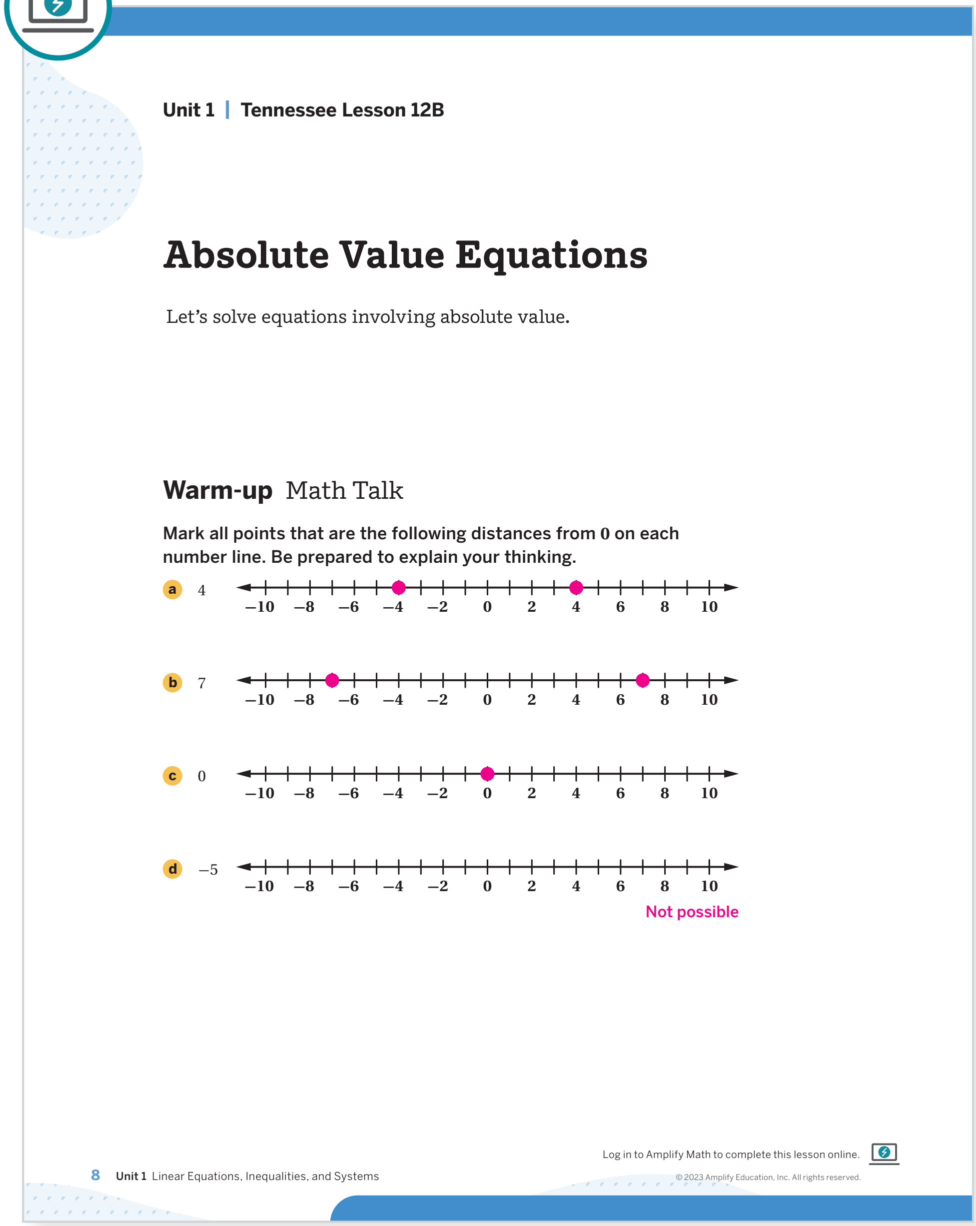
You may want to consider this additional modification if you are short on time.

- In **Activity 2**, Problems 2 and 4 may be omitted.

Warm-up Math Talk

MP6
A1.A.REI.B.2b

Students mark points on a number line a given distance from 0 to activate prior knowledge about absolute value and to prompt the use of precise mathematical language **(MP6).**



Unit 1 | Tennessee Lesson 12B

Absolute Value Equations

Let's solve equations involving absolute value.

Warm-up Math Talk

Mark all points that are the following distances from 0 on each number line. Be prepared to explain your thinking.

a. 4

b. 7

c. 0

d. −5

Not possible

Log in to Amplify Math to complete this lesson online.

8 **Unit 1** Linear Equations, Inequalities, and Systems

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1 Launch

Bring a chair to the front of the room and stand on one side of it. Have students describe your position with respect to the chair. Then have them estimate the distance between you and the chair. Stand the same distance from the chair, but on the other side. Again, have students describe your position and then distance, with respect to the chair. Ask, "How did your answers change when I moved from one side of the chair to the other side?"

2 Monitor

Help students get started by prompting them to think of 0 as the chair in your demonstration.

Look for points of confusion:

- **Plotting two points in Problem c.** Ask, "Which point or points are 0 units from 0?"
- **Plotting points in Problem d.** Ask, "Is it possible to have a distance of −5?"

Look for productive strategies:

- Recognizing distance must be greater than or equal to 0.
- Using the term *absolute value*.

3 Connect

Display the blank number lines from the Warm-up. **Have students share** their responses and plot their solutions on the number lines displayed.

Ask:

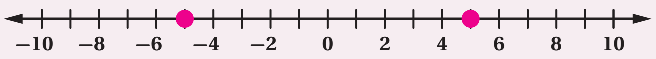
- "Why does Problem c only have one solution?"
- "Is it possible to have a distance that is negative?"
- "What equation would you write to represent the solution shown in Problem a?"

Highlight that each of the number lines in Problems a–c represent the *absolute values* of the given numbers, or their distances to 0. Display the Anchor Chart, *Absolute Value* and keep it posted for the duration of this lesson.

Power-up

To power up students' ability to recognize that absolute value is the the distance of a number from zero, have students complete:

On the number line, plot the points that satisfy the equation $|x| = 5$.



Use: Before the Activity 1

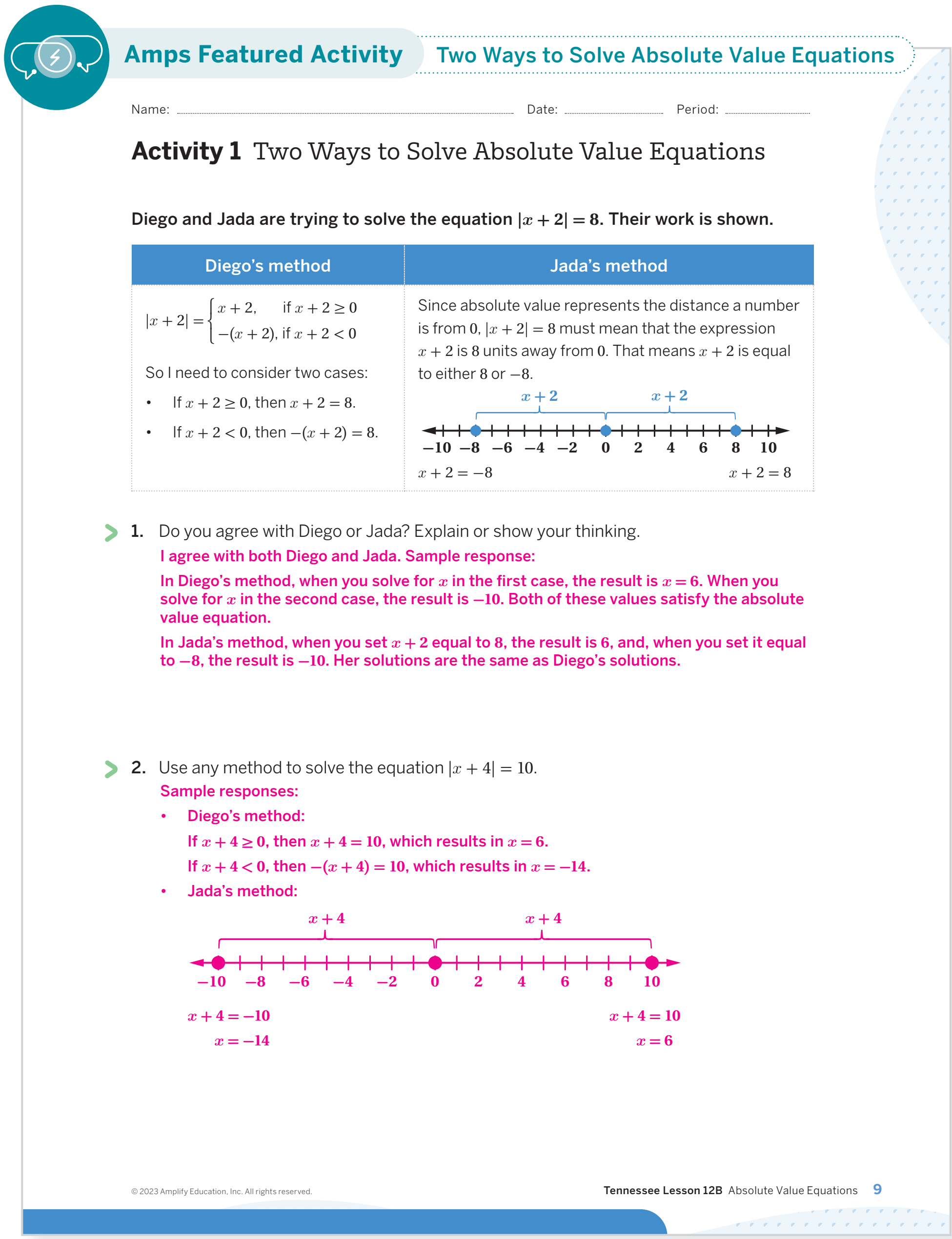
Informed by: Performance on Lesson 12A, Practice Problem 6

Pairs | 10 min

Activity 1 Two Ways to Solve Absolute Value Equations

MP7
A1.A.REI.B.2b

Students consider an algebraic and a graphical approach to solving absolute value equations and select the method that makes the most sense to them.



Amps Featured Activity Two Ways to Solve Absolute Value Equations

Name: Date: Period:

Activity 1 Two Ways to Solve Absolute Value Equations

Diego and Jada are trying to solve the equation $|x + 2| = 8$. Their work is shown.

Diego's method	Jada's method
$|x+2| = \begin{cases} x+2, & \text{if } x+2 \geq 0 \\ -(x+2), & \text{if } x+2 < 0 \end{cases}$ So I need to consider two cases: • If $x + 2 \geq 0$, then $x + 2 = 8$. • If $x + 2 < 0$, then $-(x + 2) = 8$.	Since absolute value represents the distance a number is from 0, $|x + 2| = 8$ must mean that the expression $x + 2$ is 8 units away from 0. That means $x + 2$ is equal to either 8 or -8. $x + 2$ $x + 2$ -10 -8 -6 -4 -2 0 2 4 6 8 10 $x + 2 = -8$ $x + 2 = 8$

1. Do you agree with Diego or Jada? Explain or show your thinking.

I agree with both Diego and Jada. Sample response:

In Diego's method, when you solve for x in the first case, the result is $x = 6$. When you solve for x in the second case, the result is -10. Both of these values satisfy the absolute value equation.

In Jada's method, when you set $x + 2$ equal to 8, the result is 6, and, when you set it equal to -8, the result is -10. Her solutions are the same as Diego's solutions.

2. Use any method to solve the equation $|x + 4| = 10$.

Sample responses:

- **Diego's method:**
  If $x + 4 \geq 0$, then $x + 4 = 10$, which results in $x = 6$.
  If $x + 4 < 0$, then $-(x + 4) = 10$, which results in $x = -14$.
- **Jada's method:**

$x + 4$ $x + 4$

-10 -8 -6 -4 -2 0 2 4 6 8 10

$x + 4 = -10$ $x + 4 = 10$

$x = -14$ $x = 6$

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Tennessee Lesson 12B Absolute Value Equations 9

1 Launch

Have students complete the activity independently before comparing their responses with their partner.

2 Monitor

Help students get started by reminding them about the definition of absolute value.

Look for points of confusion:

- **Negating x only when applying Diego's method.** Note the parentheses are used when Diego rewrites the absolute value equation This means the entire expression is being negated.

Look for productive strategies:

- Using substitution to check their answer.
- Solving the equation in Problem 2 using both methods to check their answer.

3 Connect

Display both methods and discuss any questions students may have about either method.

Have pairs of students share their reasoning for Problem 1 and their solutions for Problem 2. Have students explain why Diego should check his answers.

Ask:

- "How does Diego use the algebraic representation of $|x|$ to determine the solutions?
- "How does Jada use a number line to determine the solutions?"
- "Why did you choose the method you did? Can you use it to solve any absolute value equation?"

Display the Anchor Chart PDF, *Two Ways to Solve Absolute Value Equations*.

Highlight that Jada's method is beneficial for visually seeing the distance to 0 and eliminates the need to check the answers. Diego's algebraic approach can be used for more complicated equations, such as $|2x - 1| + x = 1$, which are not easily represented on a number line.

Math Language Development

MLR7: Compare and Connect

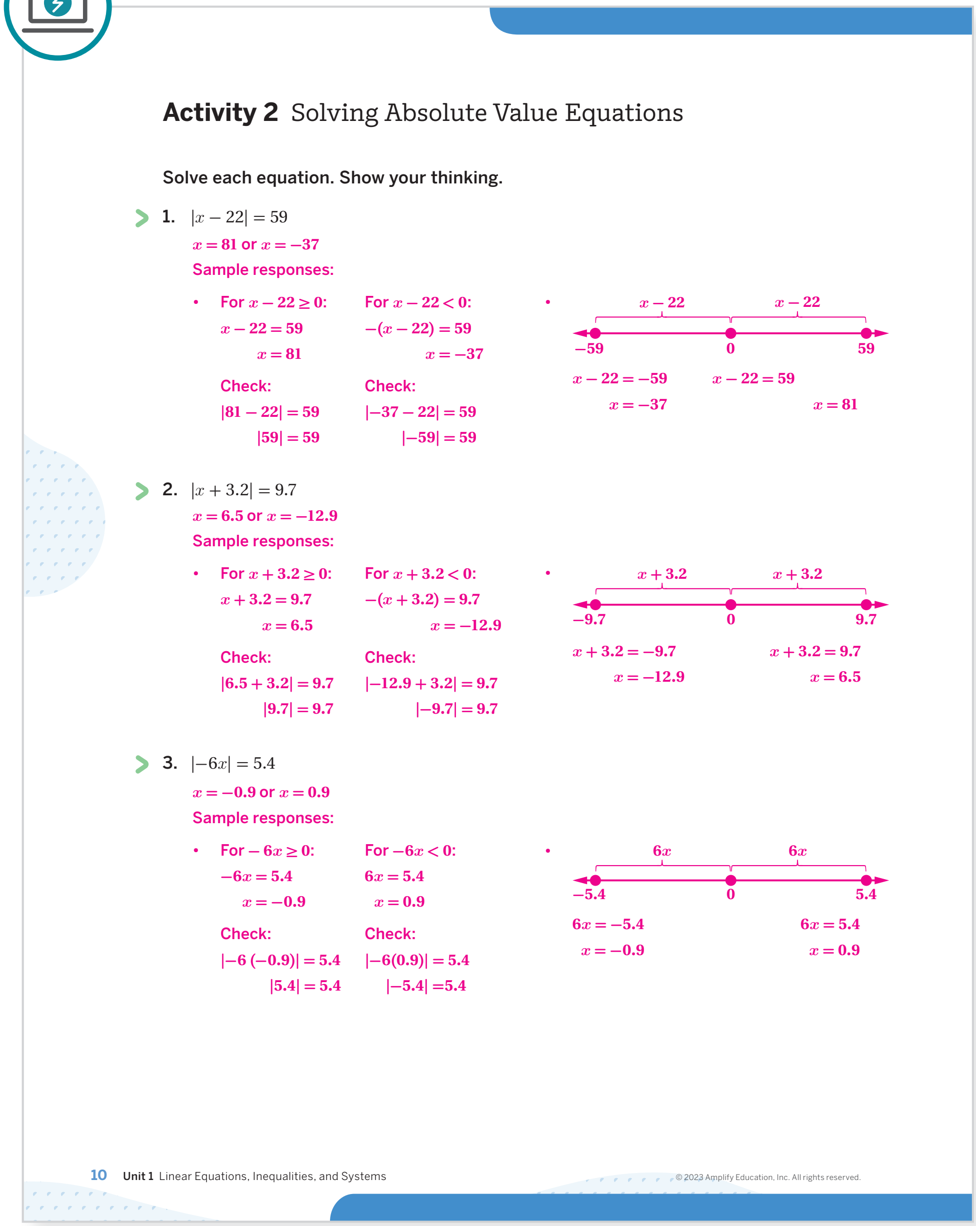
Invite student pairs to create a visual display of the strategy they used for solving the equation in Problem 2. Allow students time to quietly circulate and compare their strategy to a student pair who used a different strategy and discuss their observations with their partner. Listen for observations of advantages and disadvantages of the different approaches.

Pairs | 20 min

Activity 2 Solving Absolute Value Equations

A1.A.REI.B.2b

Students solve absolute value equations using the strategies from the previous activity to practice different ways to solve equations.



Activity 2 Solving Absolute Value Equations

Solve each equation. Show your thinking.

1. $|x - 22| = 59$

$x = 81$ or $x = -37$

Sample responses:

- For $x - 22 \geq 0$:
  $x - 22 = 59$
  $x = 81$
  Check:
  $|81 - 22| = 59$
  $|59| = 59$

  For $x - 22 < 0$:
  $-(x - 22) = 59$
  $x = -37$
  Check:
  $|-37 - 22| = 59$
  $|-59| = 59$
- $x - 22$ $x - 22$
  -59 0 59
  $x - 22 = -59$
  $x = -37$
  $x - 22 = 59$
  $x = 81$

2. $|x + 3.2| = 9.7$

$x = 6.5$ or $x = -12.9$

Sample responses:

- For $x + 3.2 \geq 0$:
  $x + 3.2 = 9.7$
  $x = 6.5$
  Check:
  $|6.5 + 3.2| = 9.7$
  $|9.7| = 9.7$

  For $x + 3.2 < 0$:
  $-(x + 3.2) = 9.7$
  $x = -12.9$
  Check:
  $|-12.9 + 3.2| = 9.7$
  $|-9.7| = 9.7$
- $x + 3.2$ $x + 3.2$
  -9.7 0 9.7
  $x + 3.2 = -9.7$
  $x = -12.9$
  $x + 3.2 = 9.7$
  $x = 6.5$

3. $|-6x| = 5.4$

$x = -0.9$ or $x = 0.9$

Sample responses:

- For $-6x \geq 0$:
  $-6x = 5.4$
  $x = -0.9$
  Check:
  $|-6(-0.9)| = 5.4$
  $|5.4| = 5.4$

  For $-6x < 0$:
  $6x = 5.4$
  $x = 0.9$
  Check:
  $|-6(0.9)| = 5.4$
  $|-5.4| = 5.4$
- $6x$ $6x$
  -5.4 0 5.4
  $6x = -5.4$
  $x = -0.9$
  $6x = 5.4$
  $x = 0.9$

1 Launch

Display Problem 1 and ask students, "What two equations would you use to solve this equation algebraically?" Keep the Anchor Chart PDF, *Two Ways to Solve Absolute Value Equations* displayed for the duration of the activity, and encourage students to choose one method to solve the equations.

2 Monitor

Help students get started by reminding them to check their solutions by substituting the solutions into the original absolute value equation.

Look for points of confusion:

- **Not knowing what to do with the numbers outside of the absolute value symbol in Problems 5 and 6.** Prompt students to rearrange the equation so that the expression inside the absolute value symbol is on one side of the equation and its distance from 0 is on the other, as with the previous problems.
- **Determining solutions $x = 2$ and $x = 10$ in Problem 6.** Prompt students to use substitution to check their solutions.

Look for productive strategies:

- Checking their answers against the absolute value intervals when using the algebraic method.
- Isolating the absolute value expression.
- Recognizing that Problem 6 has no solution because absolute value cannot be negative.

Activity 2 continued >

Differentiated Support

Extension: *Students Ready For More*

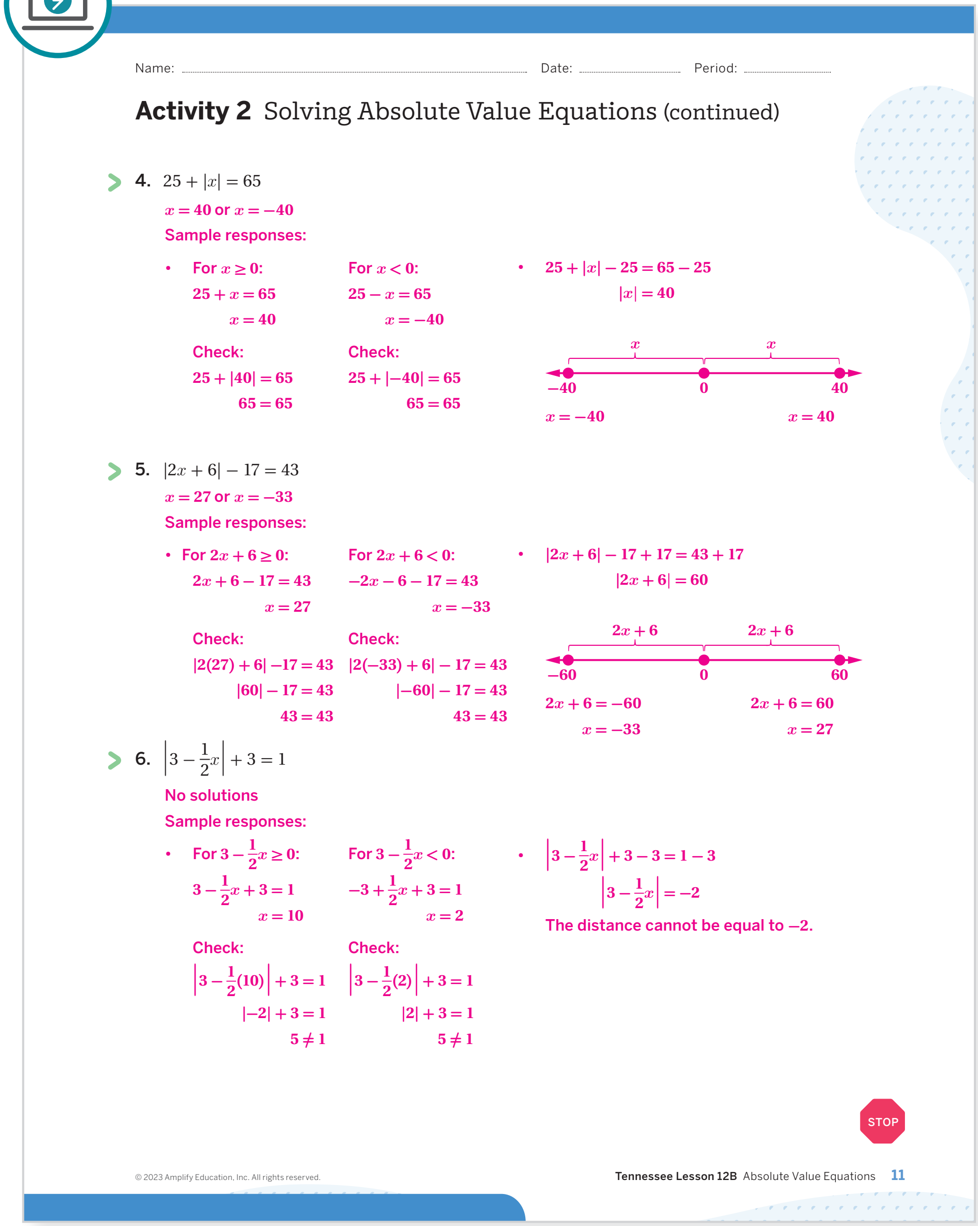
Write an absolute value equation that results in solutions that are opposites (inverses) of each other.

Pairs | 20 min

Activity 2 Solving Absolute Value Equations (continued)

A1.A.REI.B.2b

Students solve absolute value equations using the strategies from the previous activity to practice different ways to solve equations.



Name: Date: Period:

Activity 2 Solving Absolute Value Equations (continued)

4. $25 + |x| = 65$

$x = 40$ or $x = -40$

Sample responses:

- For $x \geq 0$:
  $25 + x = 65$
  $x = 40$
  Check:
  $25 + |40| = 65$
  $65 = 65$

  For $x < 0$:
  $25 - x = 65$
  $x = -40$
  Check:
  $25 + |-40| = 65$
  $65 = 65$
- $25 + |x| - 25 = 65 - 25$
  $|x| = 40$
  x x
  -40 0 40
  $x = -40$ $x = 40$

5. $|2x + 6| - 17 = 43$

$x = 27$ or $x = -33$

Sample responses:

- For $2x + 6 \geq 0$:
  $2x + 6 - 17 = 43$
  $x = 27$
  Check:
  $|2(27) + 6| -17 = 43$
  $|60| - 17 = 43$
  $43 = 43$

  For $2x + 6 < 0$:
  $-2x - 6 - 17 = 43$
  $x = -33$
  Check:
  $|2(-33) + 6| - 17 = 43$
  $|-60| - 17 = 43$
  $43 = 43$
- $|2x + 6| - 17 + 17 = 43 + 17$
  $|2x + 6| = 60$
  $2x + 6$ $2x + 6$
  -60 0 60
  $2x + 6 = -60$ $2x + 6 = 60$
  $x = -33$ $x = 27$

6. $\left|3 - \frac{1}{2}x\right| + 3 = 1$

No solutions

Sample responses:

- For $3 - \frac{1}{2}x \geq 0$:
  $3 - \frac{1}{2}x + 3 = 1$
  $x = 10$
  Check:
  $\left|3 - \frac{1}{2}(10)\right| + 3 = 1$
  $|-2| + 3 = 1$
  $5 \neq 1$

  For $3 - \frac{1}{2}x < 0$:
  $-3 + \frac{1}{2}x + 3 = 1$
  $x = 2$
  Check:
  $\left|3 - \frac{1}{2}(2)\right| + 3 = 1$
  $|2| + 3 = 1$
  $5 \neq 1$
- $\left|3 - \frac{1}{2}x\right| + 3 - 3 = 1 - 3$
  $\left|3 - \frac{1}{2}x\right| = -2$
  The distance cannot be equal to -2.

STOP

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3 Connect

Have pairs of students share their solutions and the strategies used to solve the equations. Select a student to model both strategies from the lesson.

Ask, "Why were you unable to write the two related equations in Problem 6?"

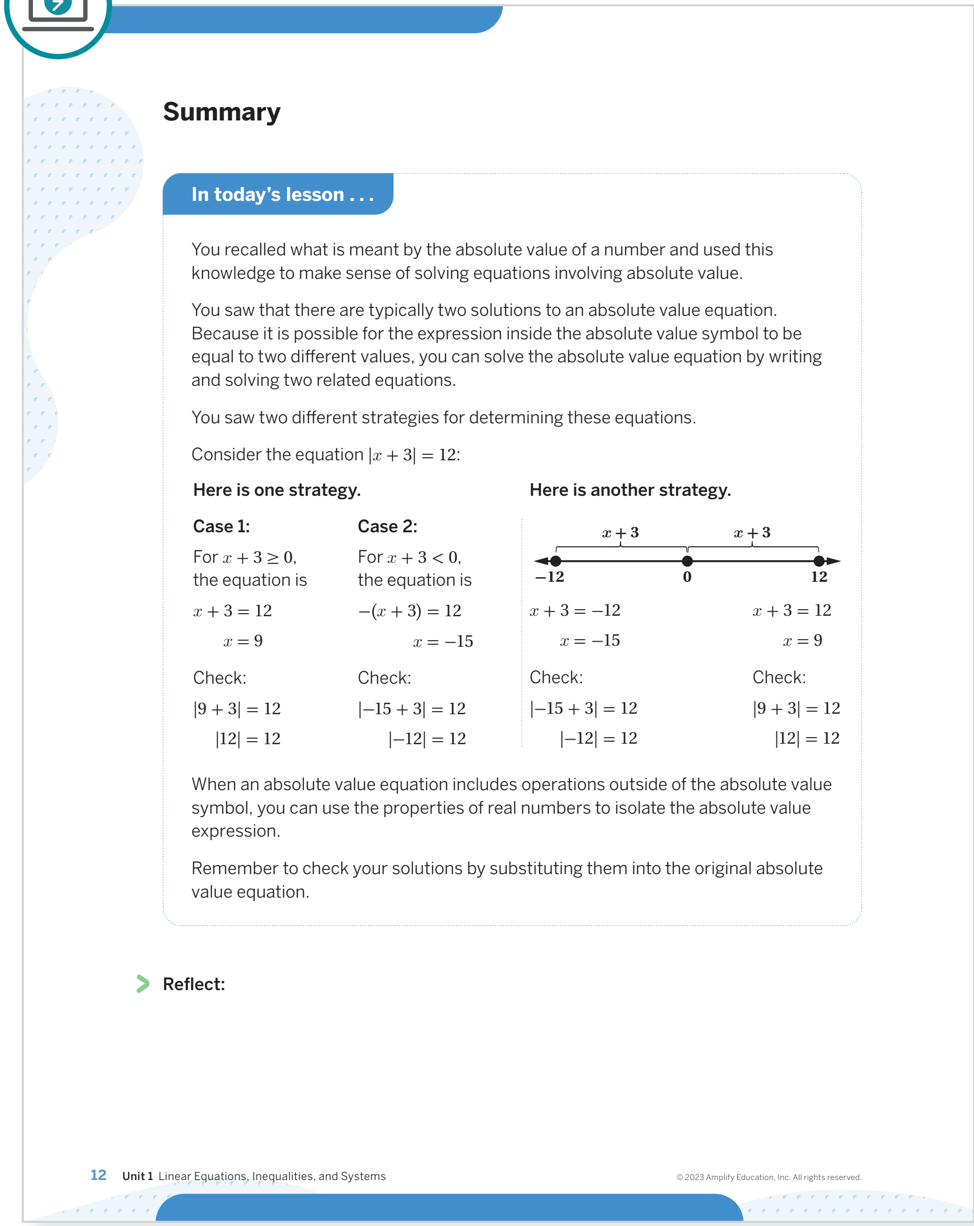
Highlight that rearranging the equation in Problem 6 resulted in an absolute value expression equal to a negative number. This is not possible because absolute value represents distance, which is a nonnegative value. Note that if students had set the expression equal to –2 and 2, it would yield an answer, but it would not satisfy the absolute value equation and the absolute value intervals. This is why it is important to check solutions against the intervals or substitute back into the original absolute value equation when using this method.

Whole Class | 5 min

Summary

A1.A.REI.B.2b

Review and synthesize the strategies for solving absolute value equations.



Summary

In today's lesson . . .

You recalled what is meant by the absolute value of a number and used this knowledge to make sense of solving equations involving absolute value.

You saw that there are typically two solutions to an absolute value equation. Because it is possible for the expression inside the absolute value symbol to be equal to two different values, you can solve the absolute value equation by writing and solving two related equations.

You saw two different strategies for determining these equations.

Consider the equation $|x + 3| = 12$:

Here is one strategy.

Case 1:

For $x + 3 \geq 0$, the equation is

$x + 3 = 12$

$x = 9$

Check:

$|9 + 3| = 12$

$|12| = 12$

Case 2:

For $x + 3 < 0$, the equation is

$-(x + 3) = 12$

$x = -15$

Check:

$|-15 + 3| = 12$

$|-12| = 12$

Here is another strategy.

$x + 3 = -12$

$x = -15$

Check:

$|-15 + 3| = 12$

$|-12| = 12$

$x + 3 = 12$

$x = 9$

Check:

$|9 + 3| = 12$

$|12| = 12$

When an absolute value equation includes operations outside of the absolute value symbol, you can use the properties of real numbers to isolate the absolute value expression.

Remember to check your solutions by substituting them into the original absolute value equation.

Reflect:

12 **Unit 1** Linear Equations, Inequalities, and Systems

Synthesize

Display the Summary from the Student Edition.

Have students share how they would derive the two related equations needed to solve the absolute value equation using each method.

Ask:

- "Which method do you prefer? Why?"
- "Have you changed your opinion from Activity 1 after solving more problems?"

Highlight the importance of checking the solutions when solving absolute value equations algebraically. Remind students that the absolute value expression must equal a nonnegative number to have a solution.

Reflect

After synthesizing the concepts of the lesson, allow students a few moments for reflection. Encourage them to record any notes in the *Reflect* space provided in the Student Edition. To help them engage in meaningful reflection, consider asking:

- "How does your preferred strategy for solving absolute value equations follow from the definition of the term *absolute value*?"

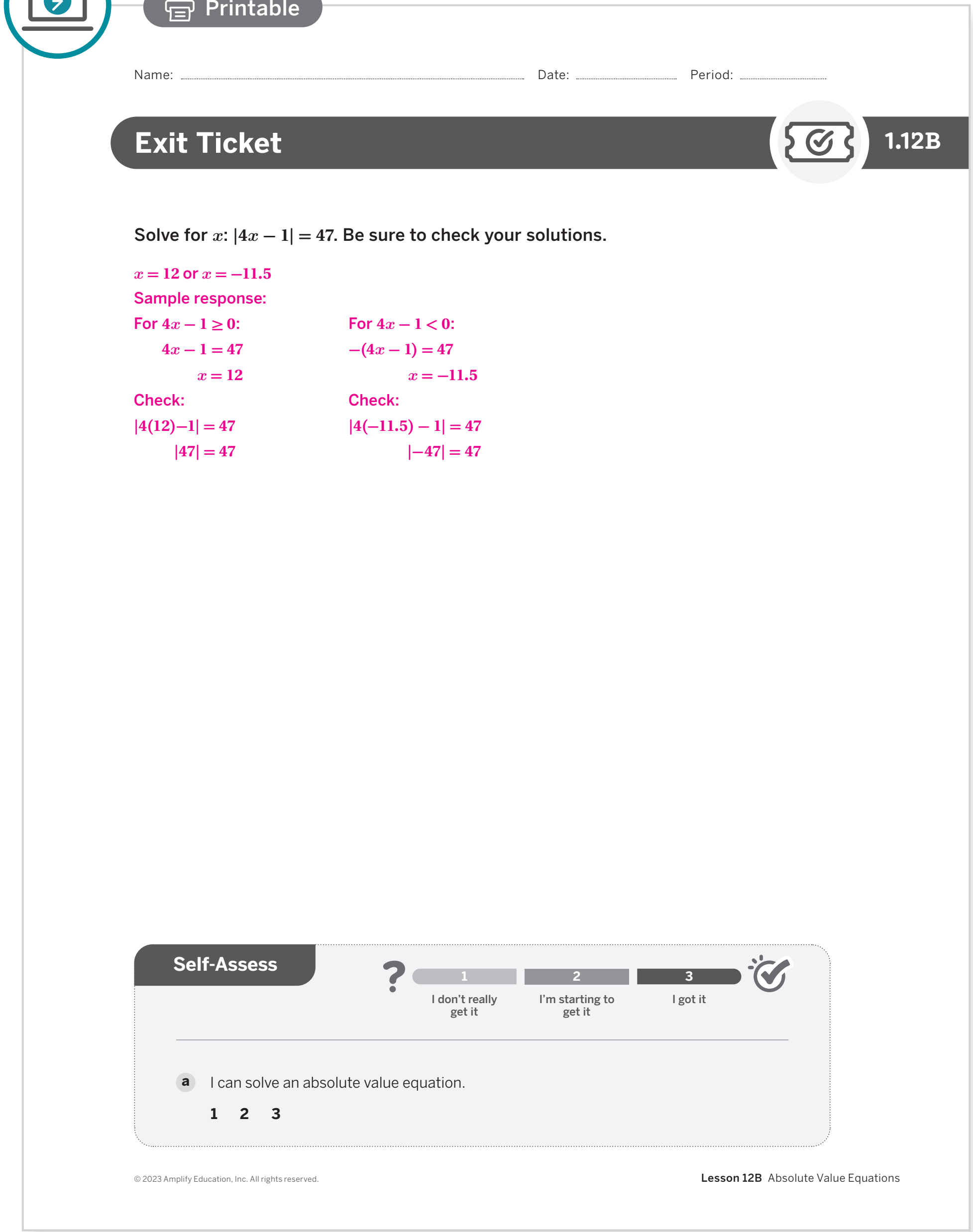
Independent | 5 min

Exit Ticket

A1.A.REI.B.2b

Students demonstrate their understanding of solving absolute value equations in one variable.

Printable



Name: ____________ Date: ________ Period: ________

Exit Ticket

1.12B

Solve for x: $|4x - 1| = 47$. Be sure to check your solutions.

$x = 12$ or $x = -11.5$

Sample response:

For $4x - 1 \geq 0$:

$4x - 1 = 47$

$x = 12$

Check:

$|4(12) - 1| = 47$

$|47| = 47$

For $4x - 1 < 0$:

$-(4x - 1) = 47$

$x = -11.5$

Check:

$|4(-11.5) - 1| = 47$

$|-47| = 47$

Self-Assess

1	2	3
I don't really get it	I'm starting to get it	I got it

a I can solve an absolute value equation.

1 2 3

Lesson 12B Absolute Value Equations

Success looks like . . .

- **Language Goal:** Determining the solutions of absolute value equations in one variable. **(Reading and Writing)**
  - » Using two related equations to solve the given equation and substituting to check the solutions.

Suggested next steps

If students do not set up two equations, consider:

- Reviewing the Anchor Chart PDF, *Two Ways of Solving Absolute Value Equations*.
- Reviewing Activity 2.
- Assigning Practice Problem 2.

Professional Learning

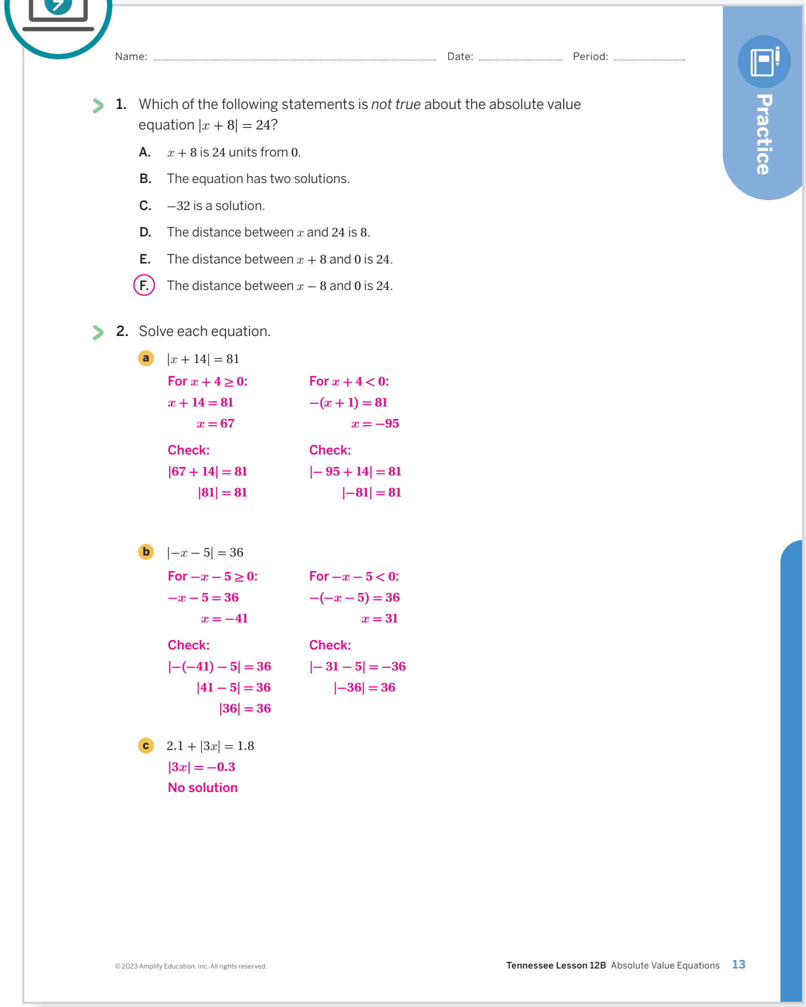
This professional learning moment is designed to be completed independently or collaboratively with your fellow mathematics educators. Prompts are provided so that you can reflect on this lesson before moving on to the next lesson.

Points to Ponder . . .

- What worked and didn't work today? Thinking about the questions you asked students today and what the students said or did as a result of the questions, which question was the most effective?
- In this lesson, students solved absolute value equations. How did that build on the earlier work students did with solving linear equations? What might you change the next time you teach this lesson?

Practice

Independent



Practice

Name: Date: Period:

1. Which of the following statements is *not true* about the absolute value equation $|x + 8| = 24$?
   - **A.** $x + 8$ is 24 units from 0.
   - **B.** The equation has two solutions.
   - **C.** -32 is a solution.
   - **D.** The distance between x and 24 is 8.
   - **E.** The distance between $x + 8$ and 0 is 24.
   - [✓ **F.**] The distance between $x - 8$ and 0 is 24.

2. Solve each equation.

a $|x + 14| = 81$

For $x + 4 \geq 0$:
$x + 14 = 81$
$x = 67$

Check:
$|67 + 14| = 81$
$|81| = 81$

For $x + 4 < 0$:
$-(x + 1) = 81$
$x = -95$

Check:
$|-95 + 14| = 81$
$|-81| = 81$

b $|-x - 5| = 36$

For $-x - 5 \geq 0$:
$-x - 5 = 36$
$x = -41$

Check:
$|-(-41) - 5| = 36$
$|41 - 5| = 36$
$|36| = 36$

For $-x - 5 < 0$:
$-(-x - 5) = 36$
$x = 31$

Check:
$|-31 - 5| = -36$
$|-36| = 36$

c $2.1 + |3x| = 1.8$
$|3x| = -0.3$
No solution

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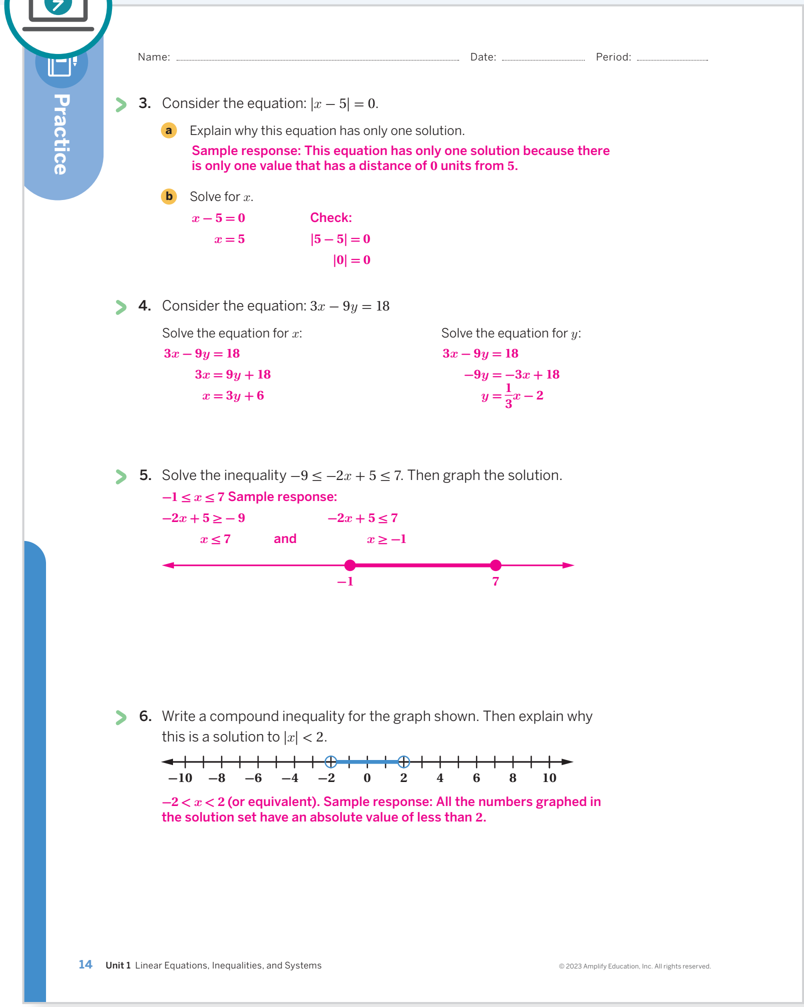
Tennessee Lesson 12B Absolute Value Equations 13



Practice

Name: Date: Period:

3. Consider the equation: $|x - 5| = 0$.

a Explain why this equation has only one solution.

Sample response: This equation has only one solution because there is only one value that has a distance of 0 units from 5.

b Solve for x.

$x - 5 = 0$
$x = 5$

Check:
$|5 - 5| = 0$
$|0| = 0$

4. Consider the equation: $3x - 9y = 18$

Solve the equation for x:
$3x - 9y = 18$
$3x = 9y + 18$
$x = 3y + 6$

Solve the equation for y:
$3x - 9y = 18$
$-9y = -3x + 18$
$y = \frac{1}{3}x - 2$

5. Solve the inequality $-9 \leq -2x + 5 \leq 7$. Then graph the solution.

$-1 \leq x \leq 7$ Sample response:

$-2x + 5 \geq -9$ and $-2x + 5 \leq 7$
$x \leq 7$ and $x \geq -1$

-1 7

6. Write a compound inequality for the graph shown. Then explain why this is a solution to $|x| < 2$.

-10 -8 -6 -4 -2 0 2 4 6 8 10

$-2 < x < 2$ (or equivalent). Sample response: All the numbers graphed in the solution set have an absolute value of less than 2.

14 **Unit 1** Linear Equations, Inequalities, and Systems

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Practice Problem Analysis

Type	Problem	Refer to	Standard(s)	DOK
On-lesson	1	Activity 1	A1.A.REI.B.2b	2
	2	Activity 2	A1.A.REI.B.2b	2
	3	Activity 2	A1.A.REI.B.2b	2
Spiral	4	Unit 1 Lesson 9	A1.A.CED.A.4	2
	5	Unit 1 Tennessee Lesson 12A	A1.A.REI.B.2a	2
Formative ⚡	6	Unit 1 Tennessee Lesson 12C	A1.A.REI.B.2b	2

⚡ **Power-up:** If students need additional support with the key prerequisite concept or skill this problem addresses, consider assigning the Power-up in the next lesson.

Additional Practice Available

For students who need additional practice in this lesson, assign the **Algebra 1 Additional Practice**.

Absolute Value Inequalities

Let’s solve inequalities involving absolute value.

Focus

Goal

1. Solve an absolute value inequality in one variable and represent the solution graphically.

Coherence

Today

Students consider the values that satisfy an absolute value inequality to determine their equivalent compound inequalities. They use this strategy of rewriting equivalent inequalities to solve absolute value inequalities in the subsequent activities and match their solutions to the number lines that represent them. Students also reason quantitatively about when an absolute value inequality would have no solution and when it would have all real numbers as a solution **(MP2)**.

Previously

In Tennessee Lesson 12A, students solved and graphed the solutions of compound inequalities and, in Tennessee Lesson 12B, students solved absolute value equations.

Coming Soon

In the next Sub-Unit, students will solve and graph linear inequalities in one- and two variables.

Rigor

- Students develop a **conceptual understanding** of absolute value inequalities and how to represent their solutions on a number line.
- Students build **fluency** by solving compound inequalities and representing the solutions graphically.

Standards

Addressing

A1.A.REI.B.2b

Solve absolute value equations and **inequalities in one variable. Represent solutions algebraically and graphically.**

Pacing Guide

Suggested Total Lesson Time ~**50 min**

Warm-up	Activity 1	Activity 2	Summary	Exit Ticket
5 min	20 min	15 min	5 min	5 min
Independent	Pairs	Pairs	Whole Class	Independent
	MP2	MP2		
A1.A.REI.B.2b	A1.A.REI.B.2b	A1.A.REI.B.2b	A1.A.REI.B.2b	A1.A.REI.B.2b

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Practice Independent

Materials

- Exit Ticket
- Additional Practice
- Activity 2 PDF, pre-cut cards, one set per pair
- Anchor Chart PDF, *Solving Inequalities* (from Grade 7, as needed)

Math Language Development

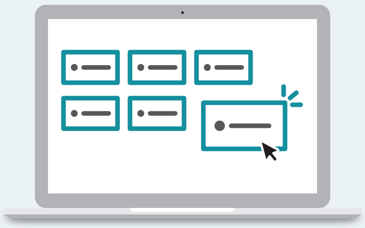
Review words

- *absolute value*
- *compound inequality*

Amps | Featured Activity

Activity 2
Digital Card Sort

Students determine the solutions of absolute value inequalities and then match the solutions to their graphical representations.



Building Math Identity and Community

Connecting to Mathematical Practices

Students may become frustrated when trying to make matches in Activity 2 or if they are unable to make sense of the graph on Card D. Encourage students to use strategies that will help them to narrow down their choices, such as sorting the cards into smaller groups or using the process of elimination to rule cards out, to increase the likelihood of making a correct match **(MP2)**.

Modifications to Pacing

You may want to consider these additional modifications if you are short on time.

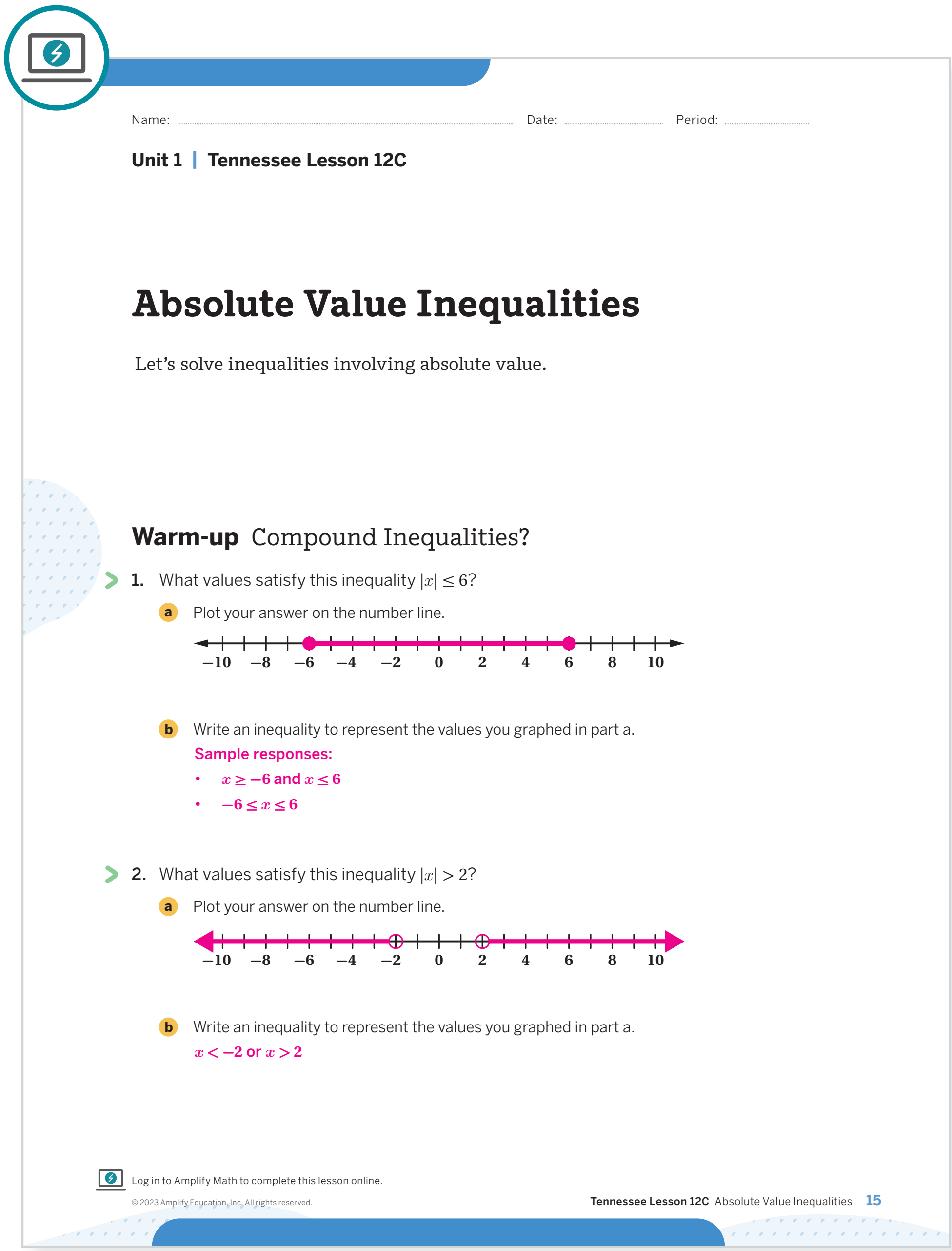
- In **Activity 1**, Problems 2 and 3 may be omitted.
- In **Activity 2**, remove Cards A and M.

Independent | 5 min

Warm-up Compound Inequalities?

A1.A.REI.B.2b

Students graph the values that satisfy two different absolute value inequalities to determine their equivalent compound inequalities.



Name: ______________ Date: ________ Period: ________

Unit 1 | Tennessee Lesson 12C

Absolute Value Inequalities

Let's solve inequalities involving absolute value.

Warm-up Compound Inequalities?

1. What values satisfy this inequality $|x| \leq 6$?

   a Plot your answer on the number line.

   b Write an inequality to represent the values you graphed in part a.

   Sample responses:
   - $x \geq -6$ and $x \leq 6$
   - $-6 \leq x \leq 6$

2. What values satisfy this inequality $|x| > 2$?

   a Plot your answer on the number line.

   b Write an inequality to represent the values you graphed in part a.

   $x < -2$ or $x > 2$

Log in to Amplify Math to complete this lesson online.

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Tennessee Lesson 12C Absolute Value Inequalities 15

1 Launch

Display the equation $|x| = 6$ and have students draw a number line to represent it, prompting them to annotate the distance to 0. Ask, "What would it mean for the absolute value of x to be less than 6?"

2 Monitor

Help students get started by prompting them to start with the graph of the related absolute value equation.

Look for points of confusion:

- **Not knowing how to determine the values that satisfy the absolute value inequality.** Have students consider different points in the intervals determined by the graph of the related absolute value equation.

Look for productive strategies:

- Substituting integer values into the inequality.

3 Connect

Display a number line for each problem and select two students to graph their solutions.

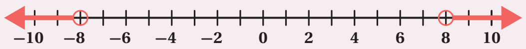
Have students share how they determined the intervals that satisfy each inequality and the compound inequalities they wrote for each number line.

Highlight that $|x| \leq 6$ means that x must be a distance of 6 units or less from 0, which can be written as $x \geq -6$ and $x \leq 6$, or simply $-6 \leq x \leq 6$. Then highlight that $|x| > 2$ means that x is greater than 2 units from 0, which can be written as $x < -2$ or $x > 2$.

Power-up

To power up students' ability to write a compound inequality to represent a graph, have students complete:

Write a compound inequality for the graph shown. Then explain why this is a solution to $|x| > 8$.



$x < -8$ or $x > 8$; Sample response: All the numbers graphed in the solution set have an absolute value greater than 8.

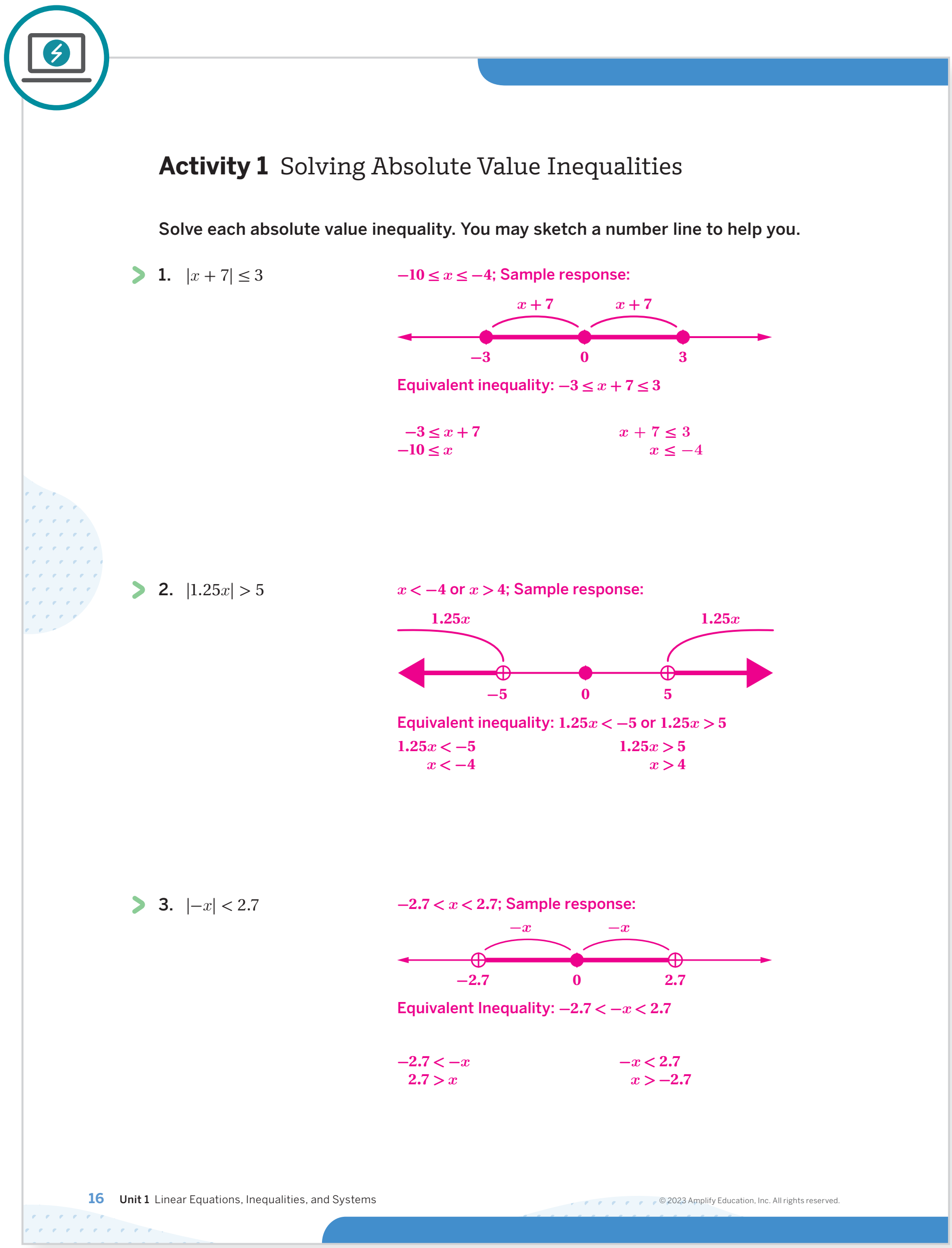
Use: Before the Warm-up
Informed by: Performance on Lesson 12B, Practice Problem 6

Pairs | 20 min

MP2
A1.A.REI.B.2b

Activity 1 Solving Absolute Value Inequalities

Students solve absolute value inequalities by writing and determining the solutions to the equivalent compound inequalities.



Activity 1 Solving Absolute Value Inequalities

Solve each absolute value inequality. You may sketch a number line to help you.

1. $|x + 7| \le 3$

$-10 \le x \le -4$; Sample response:

Equivalent inequality: $-3 \le x + 7 \le 3$

$-3 \le x + 7$
$-10 \le x$

$x + 7 \le 3$
$x \le -4$

2. $|1.25x| > 5$

$x < -4$ or $x > 4$; Sample response:

Equivalent inequality: $1.25x < -5$ or $1.25x > 5$

$1.25x < -5$
$x < -4$

$1.25x > 5$
$x > 4$

3. $|-x| < 2.7$

$-2.7 < x < 2.7$; Sample response:

Equivalent Inequality: $-2.7 < -x < 2.7$

$-2.7 < -x$
$2.7 > x$

$-x < 2.7$
$x > -2.7$

16 **Unit 1** Linear Equations, Inequalities, and Systems

1 Launch

Display Problem 1. Invite a student to sketch a number line showing the distance from 0 represented by the inequality, then annotate each interval with the expression inside the absolute value symbol. Highlight that the expression is less than or equal to 3, the distance from 0.

2 Monitor

Help students get started by prompting them to draw a number line representing the absolute value inequality first.

Look for points of confusion:

- **Not knowing how to solve linear inequalities.** Provide access to the Anchor Chart PDF, *Solving Inequalities* from Grade 7.

Look for productive strategies:

- Sketching a number line to represent the absolute value equation.
- Writing intersections for the odd-numbered problems and unions for the even-numbered problems.
- Isolating the absolute value expression in Problems 5 and 6.

Activity 1 continued >

Differentiated Support

Accessibility: *Students With Disabilities*

Engagement: Develop Effort and Persistence.

Activate prior knowledge by reminding students that they have already successfully determined solutions to compound inequalities, noting that solving absolute value inequalities is only one additional step.

Supports accessibility for: Social-emotional skills; Conceptual processing

Math Language Development

MLR7: Compare and Connect

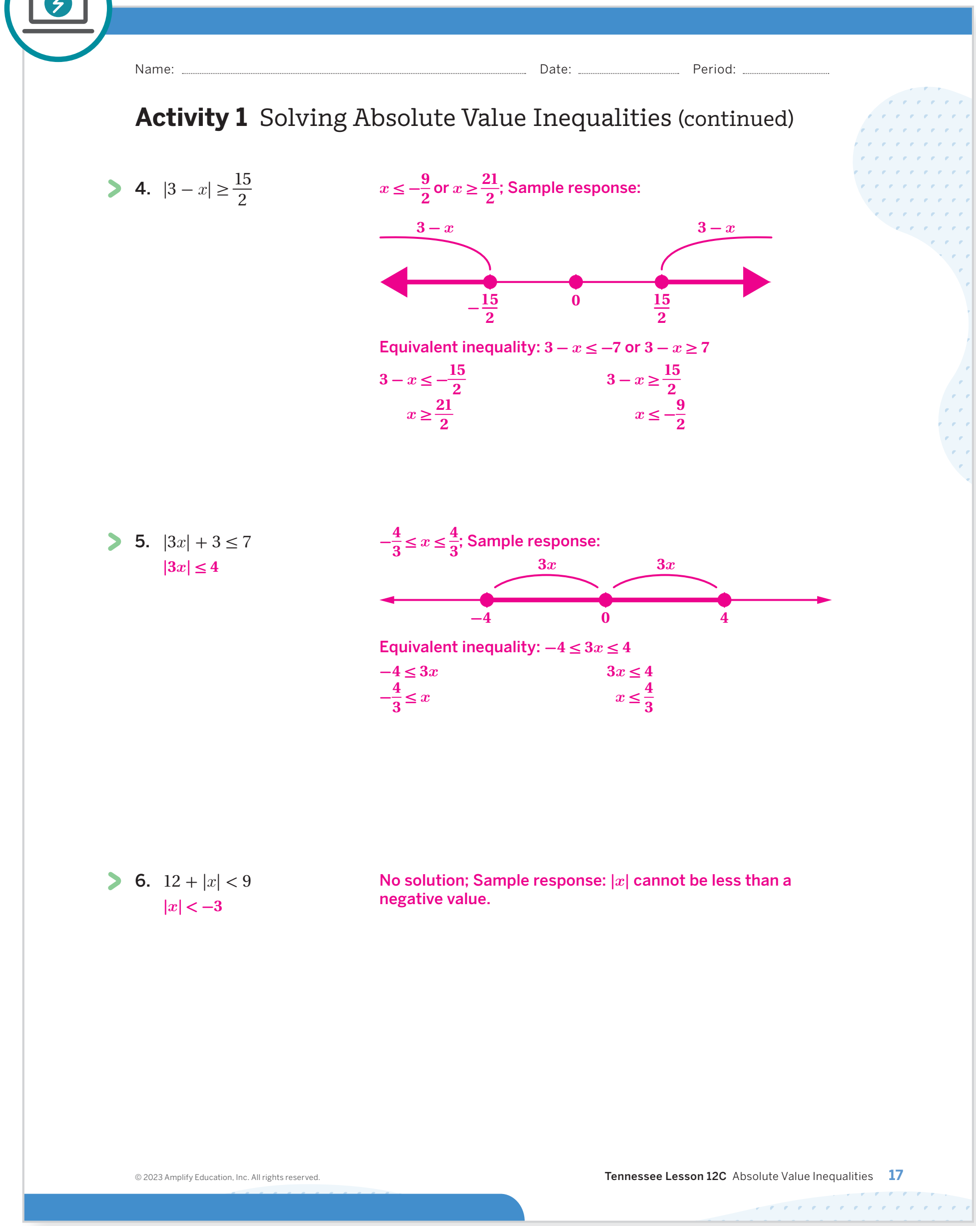
As students share their strategies, call students' attention to the steps other students took, noting what they did first, second, third, and so on. Draw connections between the equivalent inequalities students wrote and the graphs they drew, highlighting that both represent two inequalities that were solved individually.

Pairs | 20 min

Activity 1 Solving Absolute Value Inequalities (continued)

MP2
A1.A.REI.B.2b

Students solve absolute value inequalities by writing and determining the solutions to the equivalent compound inequalities.



Name: ________ Date: ________ Period: ________

Activity 1 Solving Absolute Value Inequalities (continued)

4. $|3 - x| \geq \frac{15}{2}$

$x \leq -\frac{9}{2}$ or $x \geq \frac{21}{2}$; Sample response:

Equivalent inequality: $3 - x \leq -7$ or $3 - x \geq 7$

$3 - x \leq -\frac{15}{2}$ $\quad$ $3 - x \geq \frac{15}{2}$

$x \geq \frac{21}{2}$ $\quad$ $x \leq -\frac{9}{2}$

5. $|3x| + 3 \leq 7$

$|3x| \leq 4$

$-\frac{4}{3} \leq x \leq \frac{4}{3}$; Sample response:

Equivalent inequality: $-4 \leq 3x \leq 4$

$-4 \leq 3x$ $\quad$ $3x \leq 4$

$-\frac{4}{3} \leq x$ $\quad$ $x \leq \frac{4}{3}$

6. $12 + |x| < 9$

$|x| < -3$

No solution; Sample response: $|x|$ cannot be less than a negative value.

3 Connect

Have pairs of students share the strategies they used to solve each inequality. Select students who wrote or graphed the equivalent compound inequality first before solving for x.

Highlight that the equivalent inequalities for the odd-numbered problems are all intersections and the equivalent inequalities for the even-numbered problems are all unions, except Problem 6, which has no solution. Remind students that an absolute value expression is a nonnegative value, so it can never be less than a negative value.

Ask, “How could you check that your solutions are correct?”

Highlight the three intervals formed by the boundary values in the solution set of each problem. Choose one problem to use as a model and have students sketch a graph of the solution. Note the difference between the graph of the equivalent inequality and the graph of the solution. Then have students select a test point from each interval (in the solution) and substitute them into the absolute value inequality to verify the solution is correct.

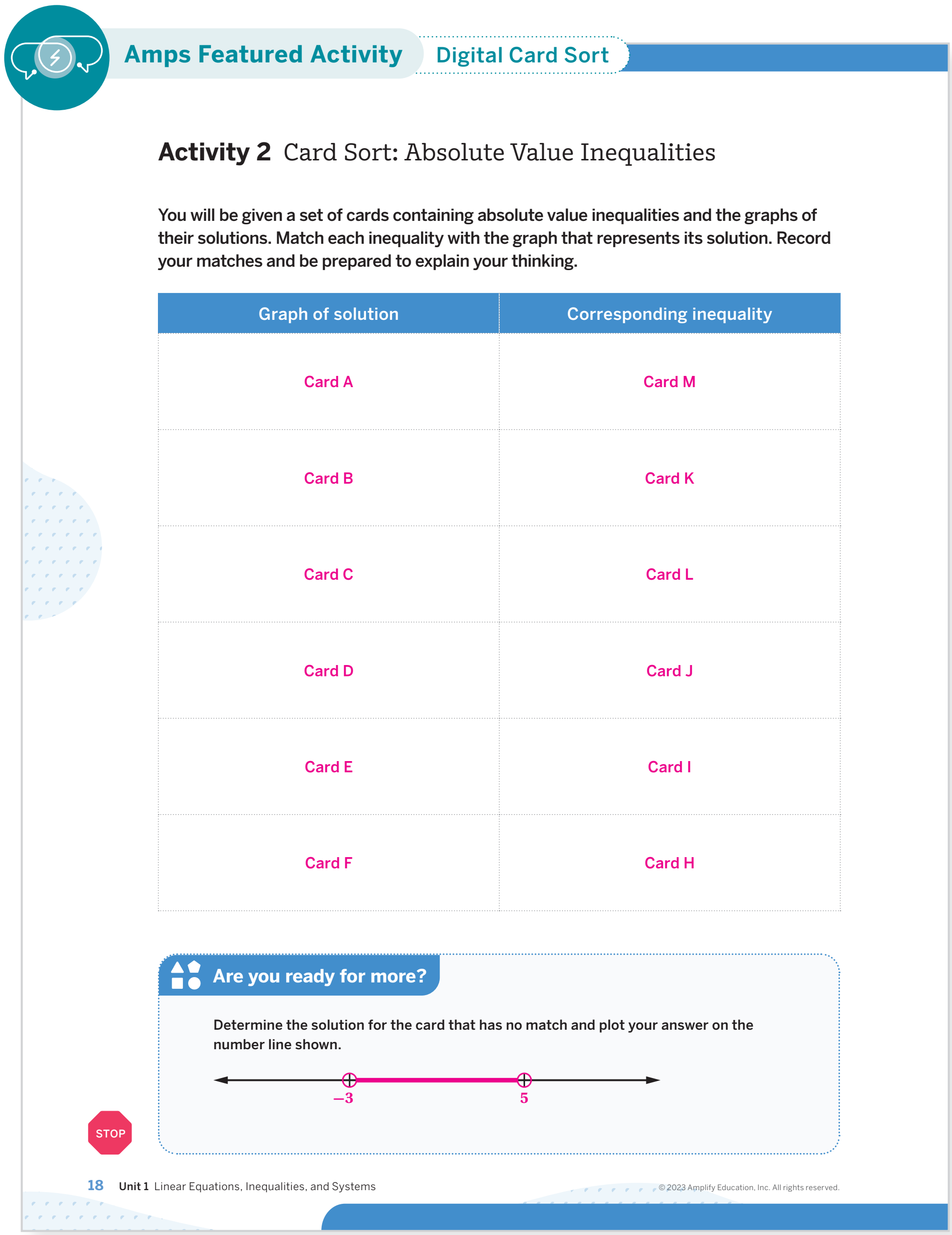
Pairs | 15 min

MP2
A1.A.REI.B.2b

Activity 2 Card Sort: Absolute Value Inequalities

Students determine solutions to absolute value inequalities so that they are able to match the inequalities with the graphs that represent their solutions.

Amps Featured Activity Digital Card Sort



Activity 2 Card Sort: Absolute Value Inequalities

You will be given a set of cards containing absolute value inequalities and the graphs of their solutions. Match each inequality with the graph that represents its solution. Record your matches and be prepared to explain your thinking.

Graph of solution	Corresponding inequality
Card A	Card M
Card B	Card K
Card C	Card L
Card D	Card J
Card E	Card I
Card F	Card H

Are you ready for more?

Determine the solution for the card that has no match and plot your answer on the number line shown.

18 Unit 1 Linear Equations, Inequalities, and Systems

1 Launch

Distribute one set of pre-cut cards from the Activity 2 PDF to student pairs. Prompt students to solve the inequalities on the cards first before attempting to make any matches.

2 Monitor

Help students get started by reminding them that the cards show the graphs of the solutions, not of the equivalent inequalities.

Look for points of confusion:

- **Substituting boundary values into the absolute value inequalities.** Remind students that the solution to an inequality is a range of values.

Look for productive strategies:

- Writing or sketching the graph of the equivalent compound inequality.
- Sorting the cards with absolute value inequalities by their inequality signs.
- Isolating the absolute value expression.
- Using test points from the intervals formed to check their solutions.

3 Connect

Have pairs of students share the matches they made and their strategies for solving the given inequalities.

Ask, "What solution does the graph on Card D represent? Which card matches Card D?"

Highlight that an absolute value expression will always be greater than a negative number because it is nonnegative. The solution for Card J is all real numbers because it does not matter what value is substituted. The result will be greater than or equal to 0.

Differentiated Support

Accessibility: *Students Who Need Help*

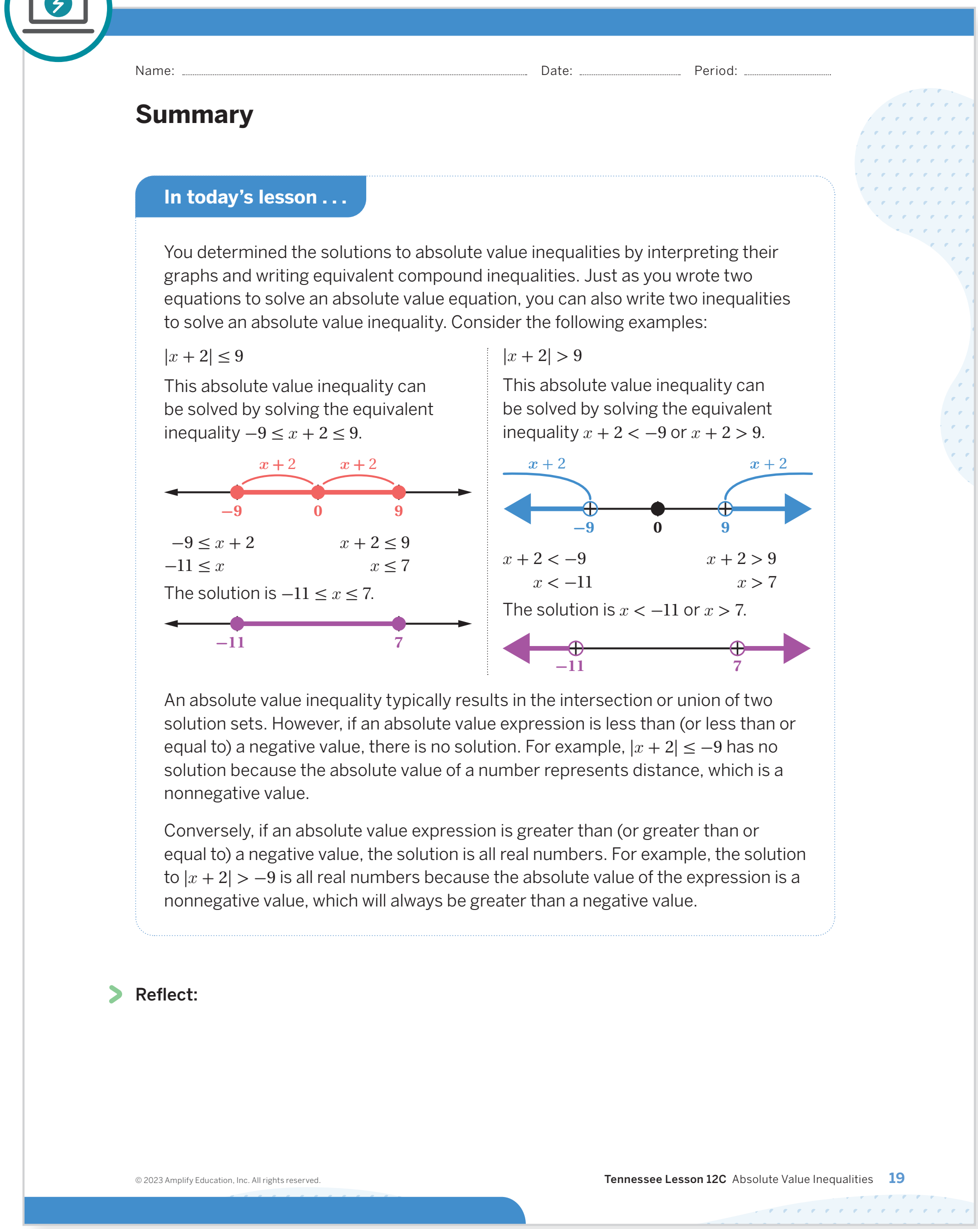
Consider grouping students that require more processing time together and reducing the number of matches they need to make.

Whole Class | 5 min

Summary

A1.A.REI.B.2b

Review and synthesize how to solve an absolute value inequality.



Name: ________________ Date: ________ Period: ________

Summary

In today's lesson . . .

You determined the solutions to absolute value inequalities by interpreting their graphs and writing equivalent compound inequalities. Just as you wrote two equations to solve an absolute value equation, you can also write two inequalities to solve an absolute value inequality. Consider the following examples:

$|x + 2| \leq 9$

This absolute value inequality can be solved by solving the equivalent inequality $-9 \leq x + 2 \leq 9$.

$-9 \leq x + 2$ $\quad$ $x + 2 \leq 9$

$-11 \leq x$ $\quad$ $x \leq 7$

The solution is $-11 \leq x \leq 7$.

$|x + 2| > 9$

This absolute value inequality can be solved by solving the equivalent inequality $x + 2 < -9$ or $x + 2 > 9$.

$x + 2 < -9$ $\quad$ $x + 2 > 9$

$x < -11$ $\quad$ $x > 7$

The solution is $x < -11$ or $x > 7$.

An absolute value inequality typically results in the intersection or union of two solution sets. However, if an absolute value expression is less than (or less than or equal to) a negative value, there is no solution. For example, $|x + 2| \leq -9$ has no solution because the absolute value of a number represents distance, which is a nonnegative value.

Conversely, if an absolute value expression is greater than (or greater than or equal to) a negative value, the solution is all real numbers. For example, the solution to $|x + 2| > -9$ is all real numbers because the absolute value of the expression is a nonnegative value, which will always be greater than a negative value.

Reflect:

Tennessee Lesson 12C Absolute Value Inequalities 19

Synthesize

Have students share the strategy they would use when solving an absolute value inequality.

Highlight why writing an equivalent inequality is helpful for solving. It enables students to solve a more familiar inequality.

Ask, "When does an absolute value inequality have no solutions? When is the solution all real numbers?"

Highlight how a number line representing the solutions of an absolute value inequality shows the interval(s) of the solution set and that substituting a test point from each interval into the inequality is a way to check whether the solution set is correct.

Reflect

After synthesizing the concepts of the lesson, allow students a few moments for reflection. Encourage them to record any notes in the *Reflect* space provided in the Student Edition. To help them engage in meaningful reflection, consider asking:

- "How can you determine whether the inequality that is equivalent to an absolute value inequality gives a union or an intersection?"

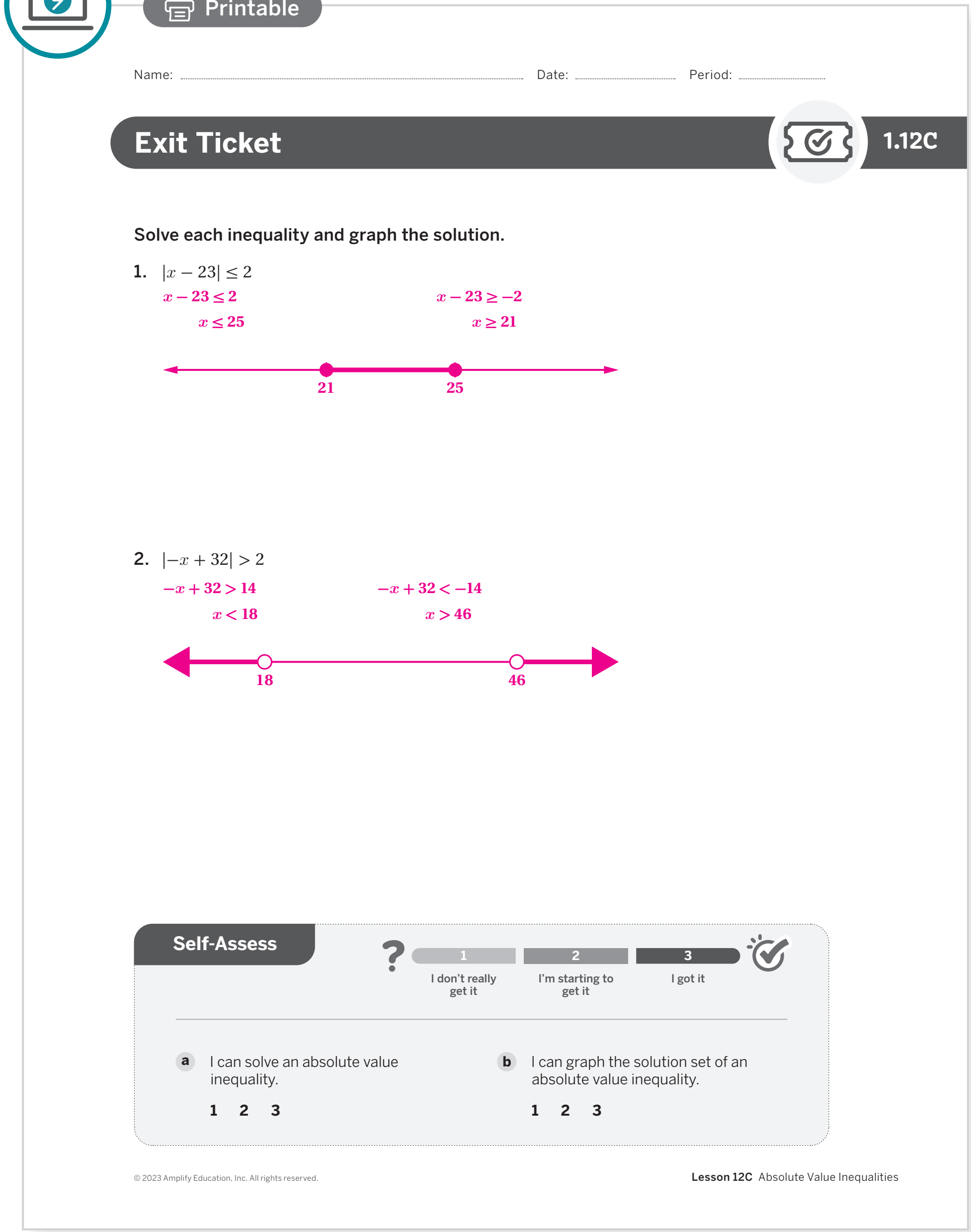
Independent | 5 min

Exit Ticket

A1.A.REI.B.2b

Students demonstrate their understanding of solving absolute value inequalities and representing their solutions graphically.

Printable



Name: Date: Period:

Exit Ticket 1.12C

Solve each inequality and graph the solution.

1. $|x - 23| \leq 2$

$x - 23 \leq 2$ $x - 23 \geq -2$

$x \leq 25$ $x \geq 21$

21 25

2. $|-x + 32| > 2$

$-x + 32 > 14$ $-x + 32 < -14$

$x < 18$ $x > 46$

18 46

Self-Assess

1	2	3
I don't really get it	I'm starting to get it	I got it

a I can solve an absolute value inequality.

1 2 3

b I can graph the solution set of an absolute value inequality.

1 2 3

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Lesson 12C Absolute Value Inequalities

Success looks like . . .

- **Goal:** Solving an absolute value inequality in one variable and representing the solution graphically.
  - » Determining the correct solutions to the given absolute value inequalities and graphing the solutions in Problems 1–2.

Suggested next steps

If students are unable to solve the inequalities in Problems 1 or 2, consider:

- Reviewing Activity 1.
- Assigning Practice Problem 1.
- Asking, "What inequality is equivalent to the given absolute value inequality?"

If students are unable to graph their solution, consider:

- Reviewing Activity 2.
- Assigning Practice Problem 1.

Professional Learning

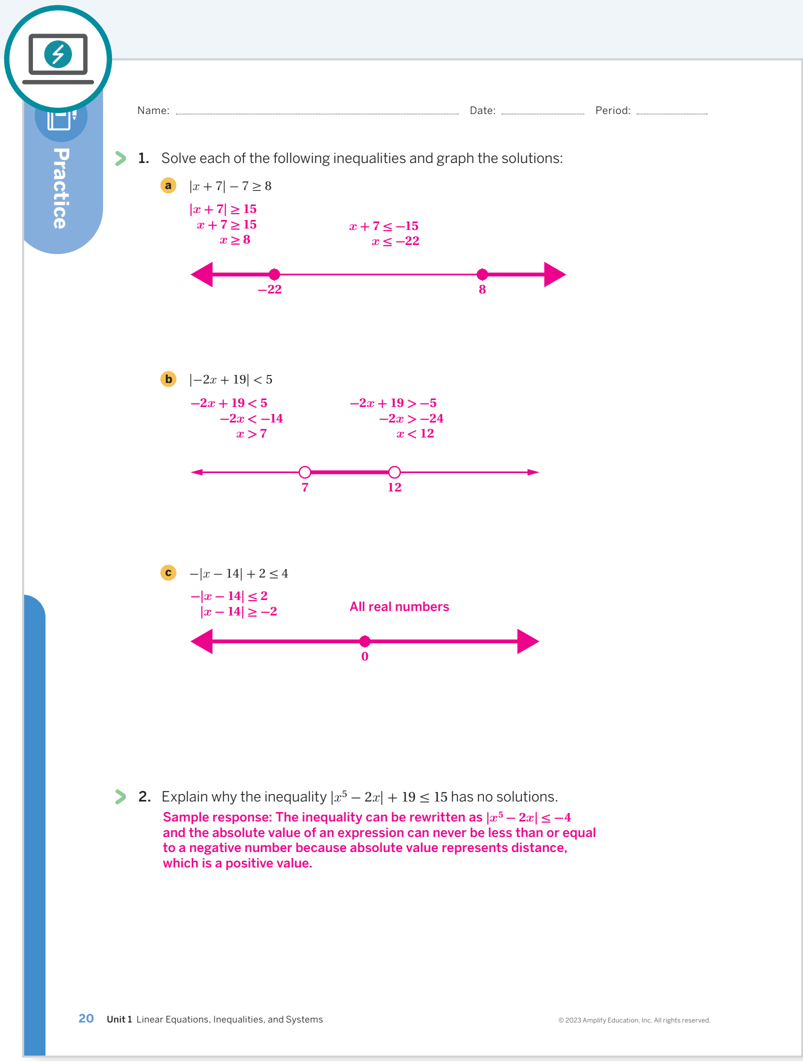
This professional learning moment is designed to be completed independently or collaboratively with your fellow mathematics educators. Prompts are provided so that you can reflect on this lesson before moving on to the next lesson.

Points to Ponder . . .

- What worked and didn't work today? What trends do you see in participation?
- In this lesson, students solved absolute value inequalities. How did that build on the earlier work students did with compound inequalities? What might you change the next time you teach this lesson?

Practice

Independent



Name: ________ Date: ________ Period: ________

1. Solve each of the following inequalities and graph the solutions:

   a. $|x+7|-7\geq 8$

   $|x+7|\geq 15$
   $x+7\geq 15$
   $x\geq 8$

   $x+7\leq -15$
   $x\leq -22$

   b. $|-2x+19|<5$

   $-2x+19<5$
   $-2x<-14$
   $x>7$

   $-2x+19>-5$
   $-2x>-24$
   $x<12$

   c. $-|x-14|+2\leq 4$

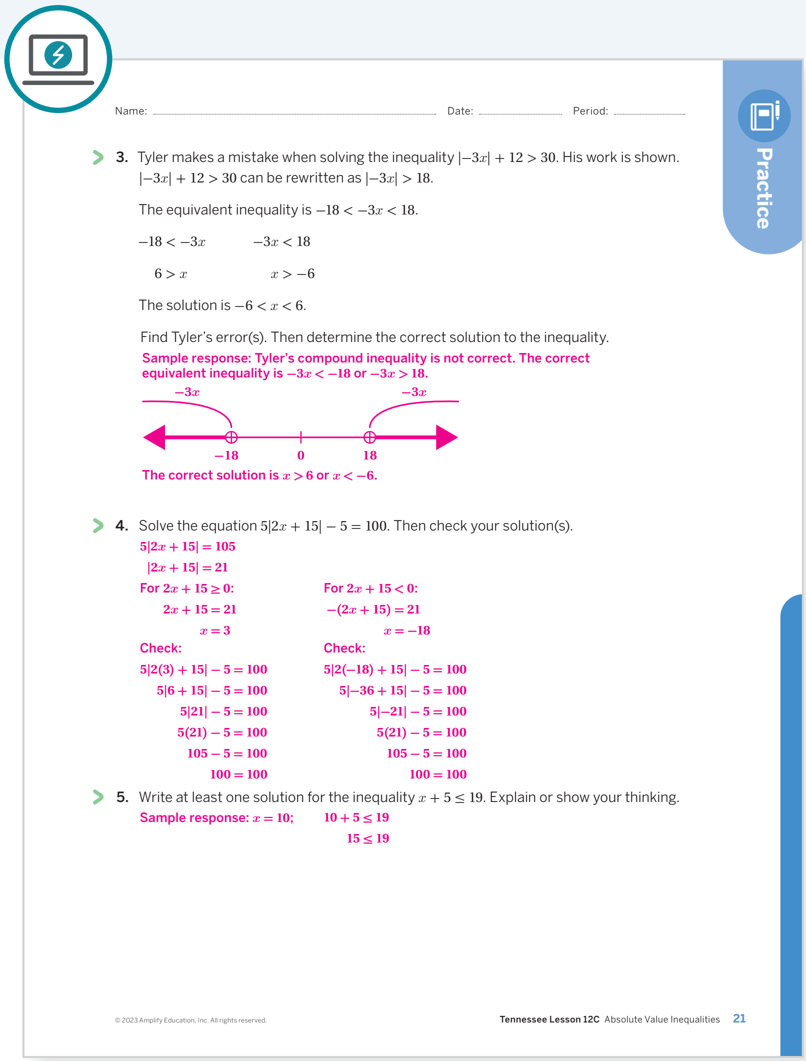
   $-|x-14|\leq 2$
   $|x-14|\geq -2$

   All real numbers

2. Explain why the inequality $|x^5-2x|+19\leq 15$ has no solutions.

   Sample response: The inequality can be rewritten as $|x^5-2x|\leq -4$ and the absolute value of an expression can never be less than or equal to a negative number because absolute value represents distance, which is a positive value.

20 **Unit 1** Linear Equations, Inequalities, and Systems



Name: ________ Date: ________ Period: ________

3. Tyler makes a mistake when solving the inequality $|-3x|+12>30$. His work is shown.
   $|-3x|+12>30$ can be rewritten as $|-3x|>18$.

   The equivalent inequality is $-18<-3x<18$.

   $-18<-3x$ $\quad$ $-3x<18$

   $6>x$ $\quad$ $x>-6$

   The solution is $-6<x<6$.

   Find Tyler's error(s). Then determine the correct solution to the inequality.

   Sample response: Tyler's compound inequality is not correct. The correct equivalent inequality is $-3x<-18$ or $-3x>18$.

   The correct solution is $x>6$ or $x<-6$.

4. Solve the equation $5|2x+15|-5=100$. Then check your solution(s).

   $5|2x+15|=105$
   $|2x+15|=21$

For $2x+15\geq 0$:	For $2x+15<0$:
$2x+15=21$	$-(2x+15)=21$
$x=3$	$x=-18$
Check:	Check:
$5\lvert 2(3)+15\rvert-5=100$	$5\lvert 2(-18)+15\rvert-5=100$
$5\lvert 6+15\rvert-5=100$	$5\lvert -36+15\rvert-5=100$
$5\lvert 21\rvert-5=100$	$5\lvert -21\rvert-5=100$
$5(21)-5=100$	$5(21)-5=100$
$105-5=100$	$105-5=100$
$100=100$	$100=100$

5. Write at least one solution for the inequality $x+5\leq 19$. Explain or show your thinking.

   Sample response: $x=10$; $\quad 10+5\leq 19$
   $15\leq 19$

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Practice Problem Analysis

Type	Problem	Refer to	Standard(s)	DOK
On-lesson	1	Activity 2	A1.A.REI.B.2b	2
	2	Activity 1	A1.A.REI.B.2b	2
	3	Activity 1	A1.A.REI.B.2b	3
Spiral	4	Unit 1 Tennessee Lesson 12B	A1.A.REI.B.2b	2
Formative ⚡	5	Unit 1 Lesson 13	A1.A.CED.A.1	2

⚡ **Power-up:** If students need additional support with the key prerequisite concept or skill this problem addresses, consider assigning the Power-up in the next lesson.

Additional Practice Available

For students who need additional practice in this lesson, assign the **Algebra 1 Additional Practice**.

Solving Systems of Linear Equations

Let's solve systems of linear equations.

Focus

Goals

1. **Language Goal:** Correlate the solution of an equation with variables on both sides of the solution to a system of two linear equations. **(Speaking and Listening)**
2. **Language Goal:** Generalize a process for solving systems of equations and calculate the values that are a solution to a system of linear equations. **(Speaking and Listening, Writing)**

Coherence

Today

Students solve a system of linear equations, where the equations are written in slope-intercept form. Students associate solving a system of linear equations with solving an equation when they set two y-values equal to each other to solve for x. They build fluency in solving systems of equations, and critique the reasoning of others as they complete *Partner Problems* **(MP3)**.

Previously

In Lesson 17, students were reminded that a solution to a system of equations is the pair of values that meet the constraints of both equations. In Grade 8, students solved equations with variables on both sides.

Coming Soon

In Lesson 18, students will consider different algebraic strategies for solving a system of equations.

Rigor

- Students solve systems of linear equations to build **fluency**.

Standards

Addressing

A1.A.REI.C.4
Write and solve a system of linear equations in real-world context.

Pacing Guide

Suggested Total Lesson Time ~**50 min**

Warm-up	Activity 1	Activity 2	Summary	Exit Ticket
5 min	15 min	20 min	5 min	5 min
Pairs	Pairs	Pairs	Whole Class	Independent
		MP3		
A1.A.REI.C.4	A1.A.REI.C.4	A1.A.REI.C.4	A1.A.REI.C.4	A1.A.REI.C.4

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For a digitally interactive experience of this lesson, log in to Amplify Math at **learning.amplify.com**.

Practice

Independent

Materials

- Exit Ticket
- Additional Practice
- Activity 1 PDF (for display)
- Anchor Chart PDF, *Solving Linear Equations* (from Grade 8, as needed)
- Anchor Chart PDF, *Sentence Stems, Explaining My Steps*

Math Language Development

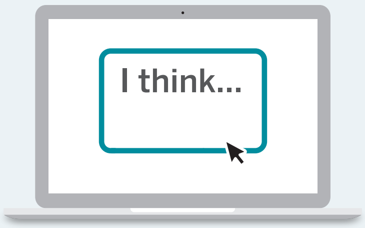
Review words

- *slope-intercept form*
- *solution to a system*
- *substitution*
- *system of equations*

Amps | Featured Activity

Activity 1
See Student Thinking

Students are asked to explain their thinking when describing how to solve a system of equations. These explanations are digitally available to you in real time.



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Building Math Identity and Community

Connecting to Mathematical Practices

As partners work to agree on a solution, they may struggle to effectively communicate. **(MP3)**. Consider providing a copy of the Anchor Chart PDF, *Sentence Stems, Explaining My Steps* to help students understand each other's thinking when solving systems of equations.

Modifications to Pacing

You may want to consider these additional modifications if you are short on time.

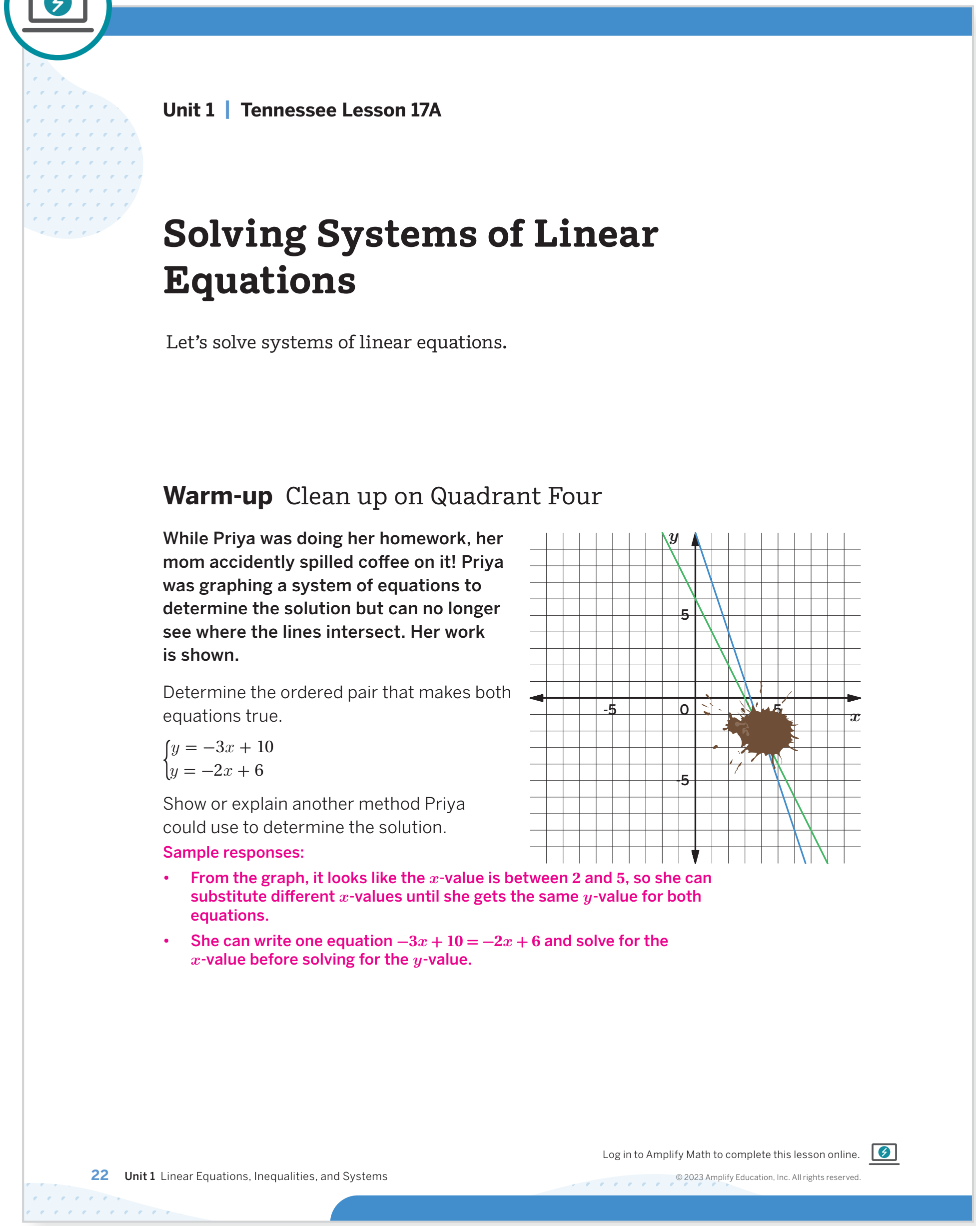
- In **Activity 2**, consider having students complete the first row and assigning the remaining problems as additional practice.

Pairs | 5 min

Warm-up Clean up on Quadrant Four

A1.A.REI.C.4

Students study the graph of a system of equations as a reminder that they do not need to graph lines to solve the system and to generate ideas for solving a system algebraically.



Unit 1 | Tennessee Lesson 17A

Solving Systems of Linear Equations

Let's solve systems of linear equations.

Warm-up Clean up on Quadrant Four

While Priya was doing her homework, her mom accidently spilled coffee on it! Priya was graphing a system of equations to determine the solution but can no longer see where the lines intersect. Her work is shown.

Determine the ordered pair that makes both equations true.

$$\begin{cases} y = -3x + 10 \\ y = -2x + 6 \end{cases}$$

Show or explain another method Priya could use to determine the solution.

Sample responses:

- **From the graph, it looks like the x-value is between 2 and 5, so she can substitute different x-values until she gets the same y-value for both equations.**
- **She can write one equation $-3x + 10 = -2x + 6$ and solve for the x-value before solving for the y-value.**

Log in to Amplify Math to complete this lesson online.

22 **Unit 1** Linear Equations, Inequalities, and Systems

1 Launch

Conduct the ***Think-Pair-Share*** routine.

2 Monitor

Help students get started by asking them how they can use the graph or equations to determine another method Priya could use.

Look for productive strategies:

- Using the visible points on the lines and the slope to estimate the ordered pair.
- Substituting values to guess the ordered pair.

3 Connect

Display the equation and graph from the Warm-up.

Have pairs of students share their responses. Select pairs of students with varying responses. Record responses for all to see.

Ask, "Which method could you use to solve the system if you were given only the equations, and not the graph?" Sample response: Write one equation by setting the y-values equal to each other.

Highlight that, to find the point of intersection, students need to determine the value of x so that both equations have the same y-value. One way to do this is to write one equation by setting the y-values equal to each other.

Differentiated Support

Accessibility: *Guide Processing and Visualization*

Provide students with a partially completed table, such as the following, to help them identify the value of x for which both equations have the same y-value.

x	$y = -3x + 10$	x	$y = -2x + 6$
2	4	2	2
3	1	3	0
4			
5			

Power-up

To power up students' ability to solve a system of linear equations without graphing, ask:

"What is the ordered pair that is a solution to the system $\begin{cases} y = 4x + 2 \\ y = x - 7 \end{cases}$?"
$(-3, -10)$

Use: After Activity 1

Informed by: Performance on Lesson 17, Practice Problem 6

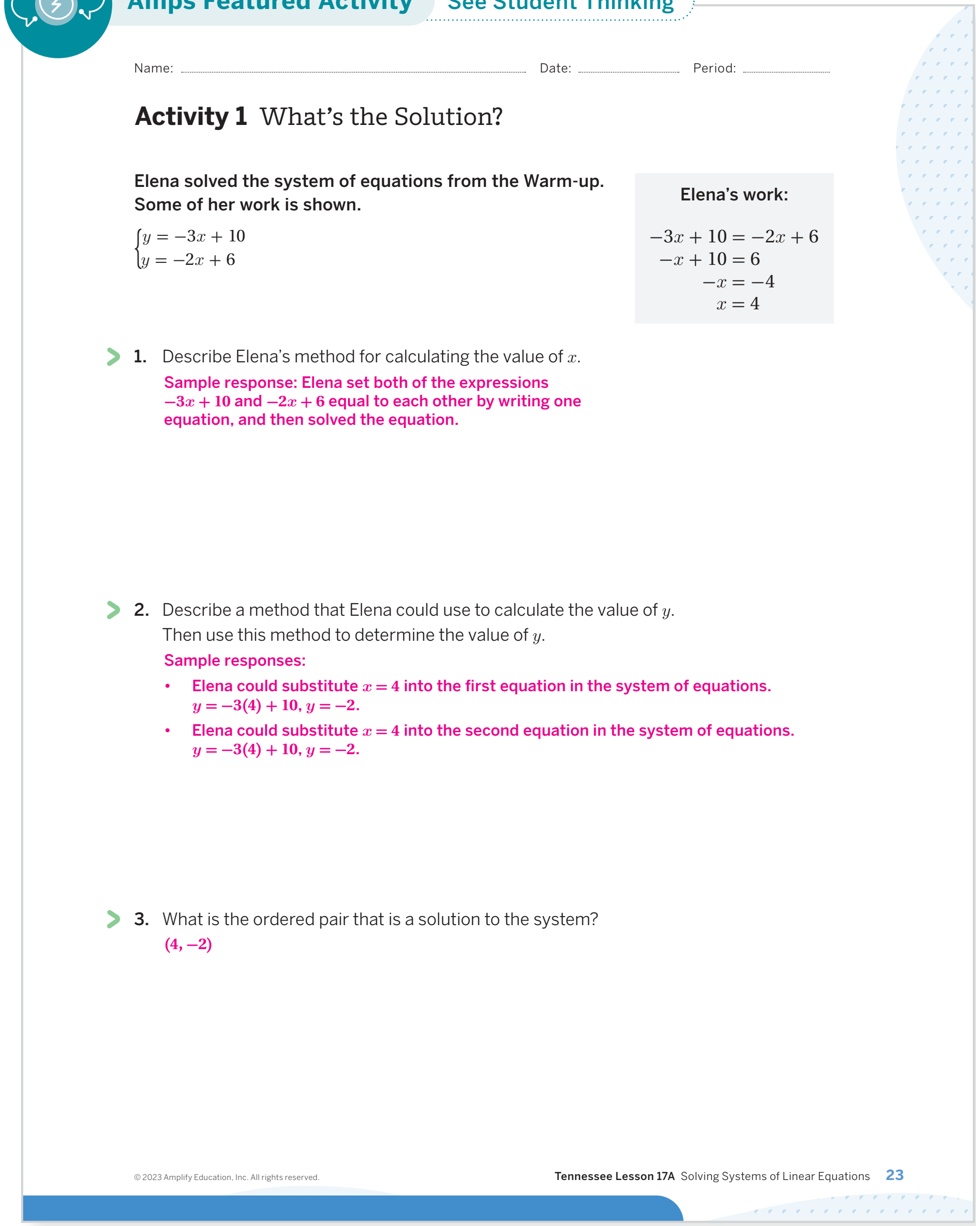
Pairs | 15 min

Activity 1 What's the Solution?

A1.A.REI.C.4

Students develop a method to solve a system of linear equations algebraically when both equations in the system are written in slope-intercept form.

Amps Featured Activity See Student Thinking



Name: ________ Date: ________ Period: ________

Activity 1 What's the Solution?

Elena solved the system of equations from the Warm-up. Some of her work is shown.

$$\begin{cases} y = -3x + 10 \\ y = -2x + 6 \end{cases}$$

Elena's work:

$$\begin{aligned} -3x + 10 &= -2x + 6 \\ -x + 10 &= 6 \\ -x &= -4 \\ x &= 4 \end{aligned}$$

1. Describe Elena's method for calculating the value of x.
   Sample response: Elena set both of the expressions $-3x + 10$ and $-2x + 6$ equal to each other by writing one equation, and then solved the equation.

2. Describe a method that Elena could use to calculate the value of y. Then use this method to determine the value of y.
   Sample responses:
   - **Elena could substitute $x = 4$ into the first equation in the system of equations. $y = -3(4) + 10$, $y = -2$.**
   - **Elena could substitute $x = 4$ into the second equation in the system of equations. $y = -3(4) + 10$, $y = -2$.**

3. What is the ordered pair that is a solution to the system?
   $(4, -2)$

Tennessee Lesson 17A Solving Systems of Linear Equations 23

1 Launch

Have students complete Problem 1 individually. Then have them share responses with a partner before completing Problems 2 and 3.

2 Monitor

Help students get started by having them review Elena's work step by step.

Look for points of confusion:

- **Not understanding Elena's work.** Use the graph from the Warm-up to point out that the point of intersection is where the y-values are equal. Then circle $-3x + 10$ and $-2x + 6$, and tell students that these represent the y-values algebraically.
- **Having trouble describing a method to calculate y.** Ask students to refer to the suggestions made in the Warm-up. For students who need more support, give them explicit instructions on how to substitute $x = 4$ in one of the equations in the system.

3 Connect

Have students share their responses for Problem 2.

Highlight that students can substitute the x value into either equation from the original system to determine the y-value but should check their answer using both equations to determine if their solution is correct. Also highlight that when students solve a system with two linear equations, the final response should have two variables written as an ordered pair (x, y).

Display the Activity 1 PDF. Ask, "Why are the y-values the same when the x-value is substituted into either equation?" Sample response: Because there is one point of intersection, no matter which line we look at, the coordinates (x, y) are the same.

Differentiated Support

Accessibility: *Vary Demands to Optimize Challenge*

Consider allowing students to verbally describe Elena's method for Problem 1, instead of writing a full explanation at first. Scribe their thinking onto a display, creating a complete sentence for them to see.

Math Language Development

MLR8: Discussion Supports

During the Connect, as students share their responses to Problem 2, display the Anchor Chart PDF, *Sentence Stems, Explaining My Steps* to help organize their thinking.

Ask:

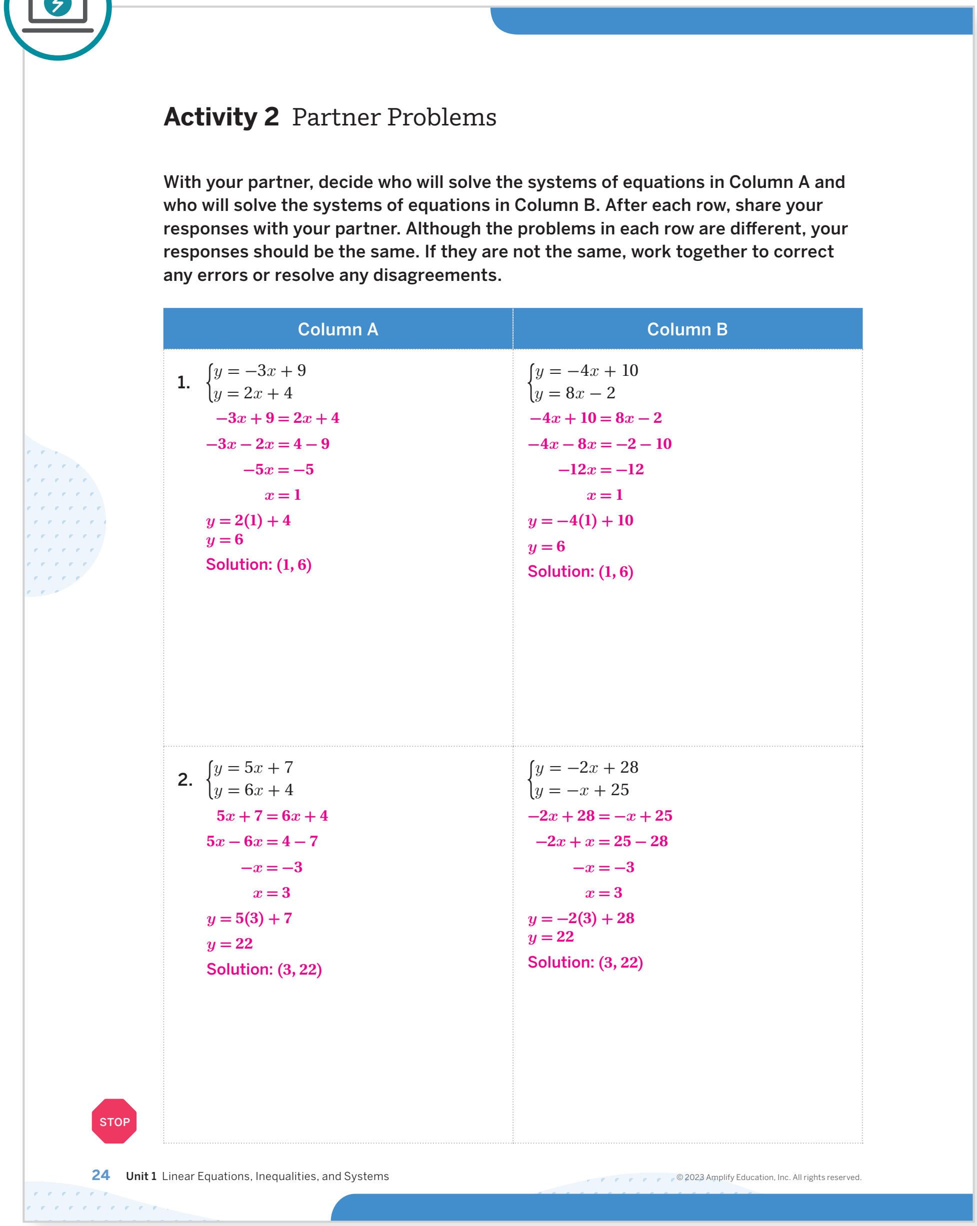
- "Does it matter which equation you use to substitute the x-value to check the solution?"
- "Is the solution $(4, -2)$ a solution to one or both equations? How do you know?"

Pairs | 20 min

Activity 2 Partner Problems

MP3
A1.A.REI.C.4

Students solve systems of linear equations to build procedural fluency.



Activity 2 Partner Problems

With your partner, decide who will solve the systems of equations in Column A and who will solve the systems of equations in Column B. After each row, share your responses with your partner. Although the problems in each row are different, your responses should be the same. If they are not the same, work together to correct any errors or resolve any disagreements.

Column A	Column B
1. $\begin{cases} y = -3x + 9 \\ y = 2x + 4 \end{cases}$ $-3x + 9 = 2x + 4$ $-3x - 2x = 4 - 9$ $-5x = -5$ $x = 1$ $y = 2(1) + 4$ $y = 6$ Solution: (1, 6)	$\begin{cases} y = -4x + 10 \\ y = 8x - 2 \end{cases}$ $-4x + 10 = 8x - 2$ $-4x - 8x = -2 - 10$ $-12x = -12$ $x = 1$ $y = -4(1) + 10$ $y = 6$ Solution: (1, 6)
2. $\begin{cases} y = 5x + 7 \\ y = 6x + 4 \end{cases}$ $5x + 7 = 6x + 4$ $5x - 6x = 4 - 7$ $-x = -3$ $x = 3$ $y = 5(3) + 7$ $y = 22$ Solution: (3, 22)	$\begin{cases} y = -2x + 28 \\ y = -x + 25 \end{cases}$ $-2x + 28 = -x + 25$ $-2x + x = 25 - 28$ $-x = -3$ $x = 3$ $y = -2(3) + 28$ $y = 22$ Solution: (3, 22)

STOP

24 **Unit 1** Linear Equations, Inequalities, and Systems

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1 Launch

Conduct the *Partner Problems* routine. Remind students that solving a system of equations means that they should have two variables written as an ordered pair for their final response. Consider providing students with additional paper to thoroughly show their thinking.

2 Monitor

Help students get started by having them write and solve a single equation using the given system of equations.

Look for points of confusion:

- **Struggling to solve a linear equation.** Provide students with a copy of the Grade 8 Anchor Chart PDF, *Solving Linear Equations*.
- **Writing one value for their solution.** Tell students that they are looking for the same x- and y-values that will make both equations true.
- **Writing an incorrect solution.** Have partners check each other's work by first checking whether the x-value is correct, and then the y-value.

Look for productive strategies:

- Substituting their x-value in both equations to check if the y-values will produce the same value.

3 Connect

Have pairs of students share any problems in which they did not have the same solution as their partner, and how they came to an agreement on their final solution **(MP3)**.

Highlight that one way students can solve a system of equations is to write a single equation to solve for one variable, then use that value and substitute it into either original equation to solve for the other variable.

Ask, "After you solve a system of equations, how could you check whether the solution is correct?" Substitute the x- and y-values into all the equations in the system. and check to see if all the equations are true.

Differentiated Support

Accessibility: *Guide Processing and Visualization*

To support students' organizational thinking, provide the following checklist for them to refer to while solving:

- Write and solve one equation for one variable.
- Substitute your answer into either equation from the original system of equations.
- Solve for the other variable.
- Write your final solution as an ordered pair (x, y).

Extension: *Math Enrichment*

Have students write a system of equations in which the ordered pair (−1, −2) is a solution to the system. Sample response: $\begin{cases} y = 5x + 3 \\ y = -2x - 4 \end{cases}$

Math Language Development

MLR8: Discussion Supports

During the Connect, as students share how they can check whether a solution is correct after solving a system of equations, press for details in their reasoning. For example:

If a student says . . .	Press for details by asking . . .
"I substituted the x-value into the equation."	• "Can you substitute the x-value into either equation?" • "If you determined a solution and it only worked in one of the equations, would this be a solution to the system? Why or why not?"

English Learners

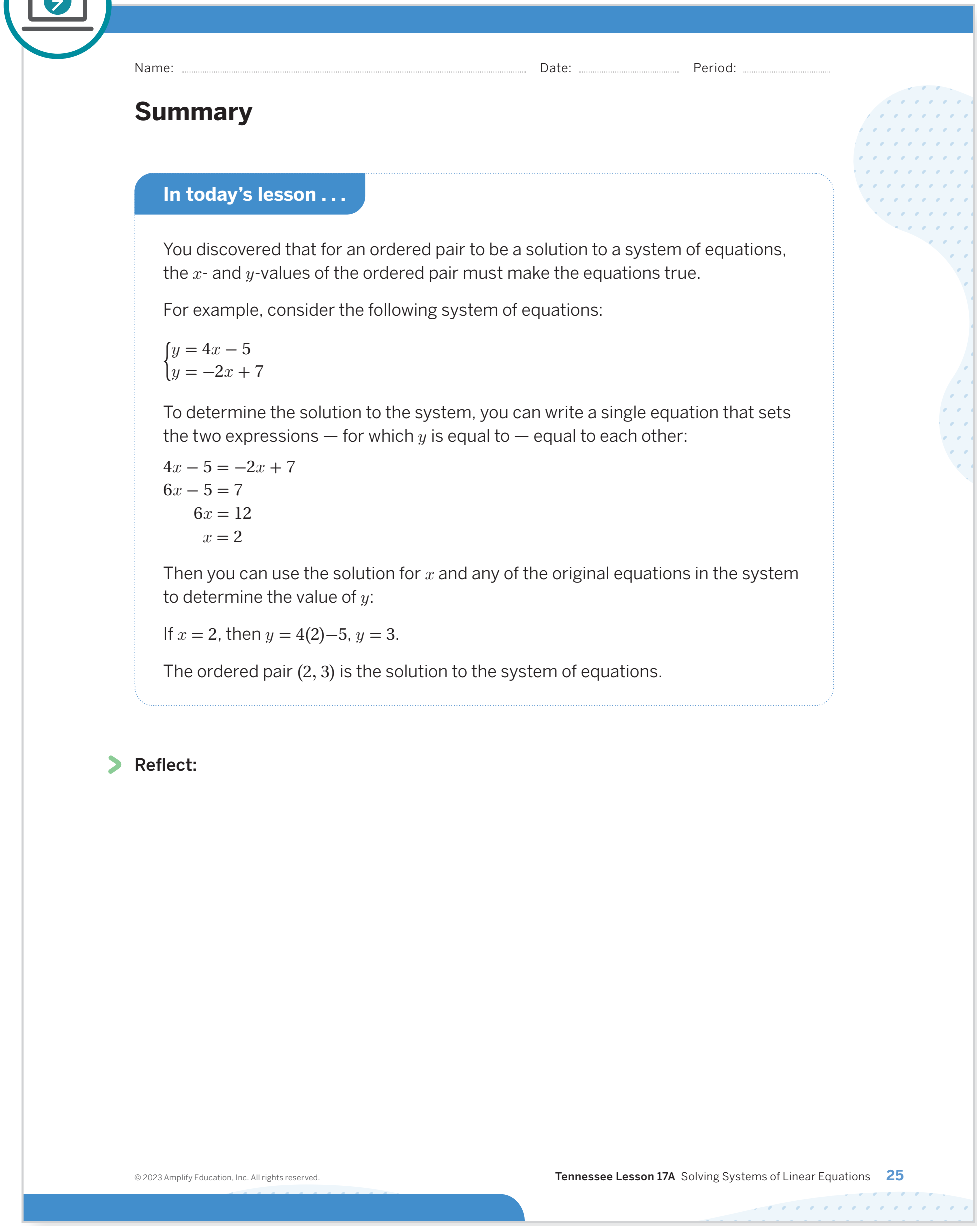
Use gestures, such as pointing to the equations and variables during the discussion.

Whole Class | 5 min

Summary

A1.A.REI.C.4

Review and synthesize the steps to solving a system of linear equations algebraically, when both equations are written in slope-intercept form.



Name: ____________ Date: ________ Period: ________

Summary

In today's lesson . . .

You discovered that for an ordered pair to be a solution to a system of equations, the x- and y-values of the ordered pair must make the equations true.

For example, consider the following system of equations:

$$\begin{cases} y = 4x - 5 \\ y = -2x + 7 \end{cases}$$

To determine the solution to the system, you can write a single equation that sets the two expressions — for which y is equal to — equal to each other:

$$\begin{aligned} 4x - 5 &= -2x + 7 \\ 6x - 5 &= 7 \\ 6x &= 12 \\ x &= 2 \end{aligned}$$

Then you can use the solution for x and any of the original equations in the system to determine the value of y:

If $x = 2$, then $y = 4(2)-5$, $y = 3$.

The ordered pair (2, 3) is the solution to the system of equations.

Reflect:

Synthesize

Ask, "How can you solve a system of equations graphically? Algebraically?"

Highlight that students solved systems of equations with specific types of equations. Tell students that in future lessons they will solve systems of equations with different forms of linear equations.

Reflect

After synthesizing the concepts of the lesson, allow students a few moments for reflection. Encourage them to record any notes in the *Reflect* space provided in the Student Edition. To help them engage in meaningful reflection, consider asking:

- "How is solving a system of linear equations similar to solving an equation with variables on both sides? How is it different?"

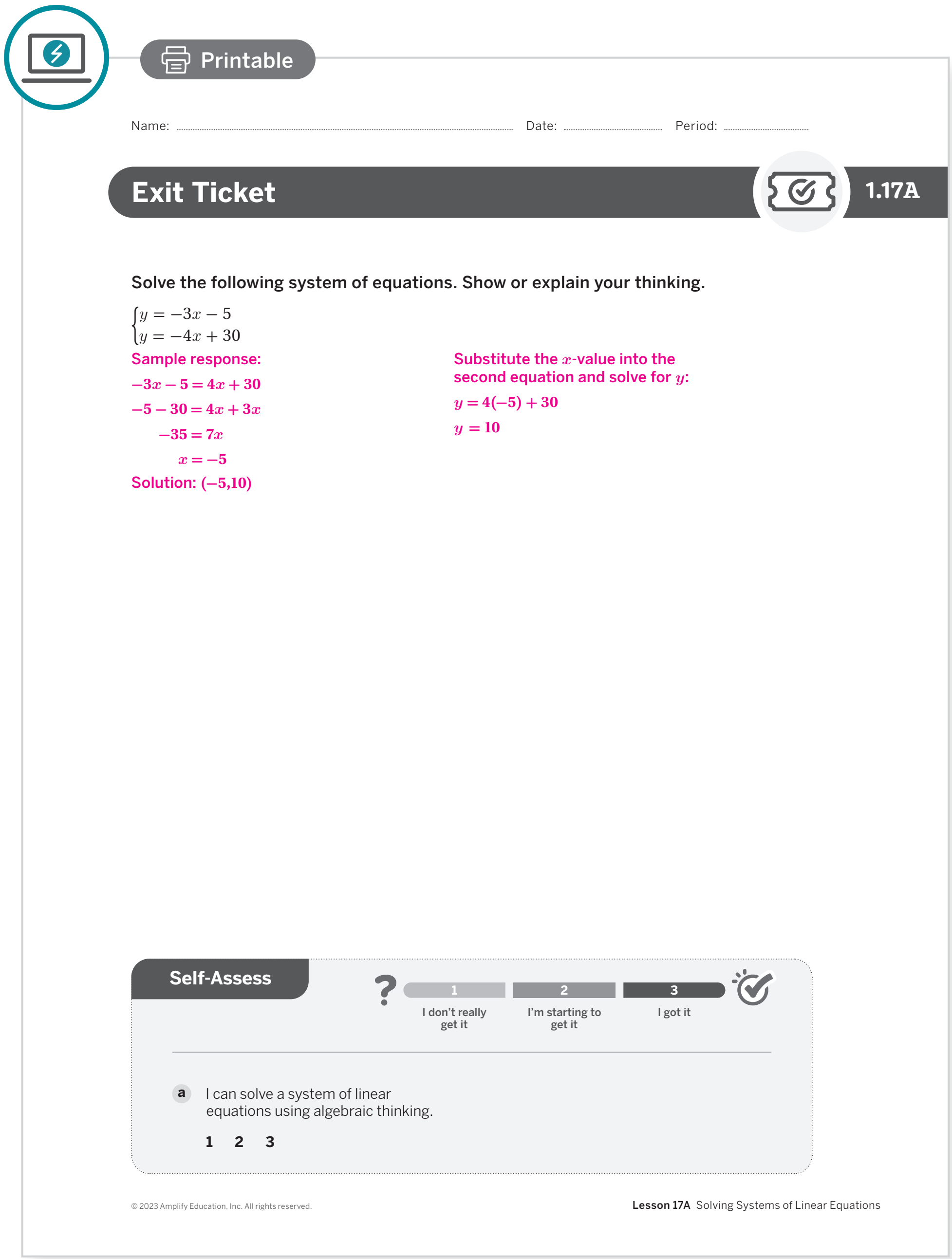
Independent | 5 min

Exit Ticket

A1.A.REI.C.4

Students demonstrate their understanding by solving a system of linear equations algebraically.

Printable



Name: ______ Date: ______ Period: ______

Exit Ticket 1.17A

Solve the following system of equations. Show or explain your thinking.

$$\begin{cases} y = -3x - 5 \\ y = -4x + 30 \end{cases}$$

Sample response:

$-3x - 5 = 4x + 30$

$-5 - 30 = 4x + 3x$

$-35 = 7x$

$x = -5$

Solution: (–5,10)

Substitute the x-value into the second equation and solve for y:

$y = 4(-5) + 30$

$y = 10$

Self-Assess

?	1	2	3
	I don't really get it	I'm starting to get it	I got it

a I can solve a system of linear equations using algebraic thinking.

1 2 3

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Lesson 17A Solving Systems of Linear Equations

Success looks like . . .

- **Language Goal:** Correlating the solution of an equation with variables on both sides of the solution to a system of two linear equations. **(Speaking and Listening)**
  - » Writing and solving a single equation to solve for the x-value.
- **Language Goal:** Generalizing a process for solving systems of equations and calculating the values that are a solution for a system of linear equations. **(Speaking and Listening, Writing)**
  - » Substituting the x-value in either equation to solve for the y-value.
  - » Including both the x- and y-value as the solution.

Suggested next step

If students do not correctly solve for x, consider:

- Having them solve the equation $-3x - 5 = 4x + 30$.
- Having them graph both equations.
- Reviewing Problem 1 in Activity 1.

If students incorrectly solve for y, consider:

- Highlighting x in either equation in the system, and having them rewrite the equation by substituting –5 for x.
- Reviewing Problem 2 in Activity 2.

If students only solve for one variable, consider:

- Reminding students that the solution to a system of equations includes both the x- *and* y-value.

Professional Learning

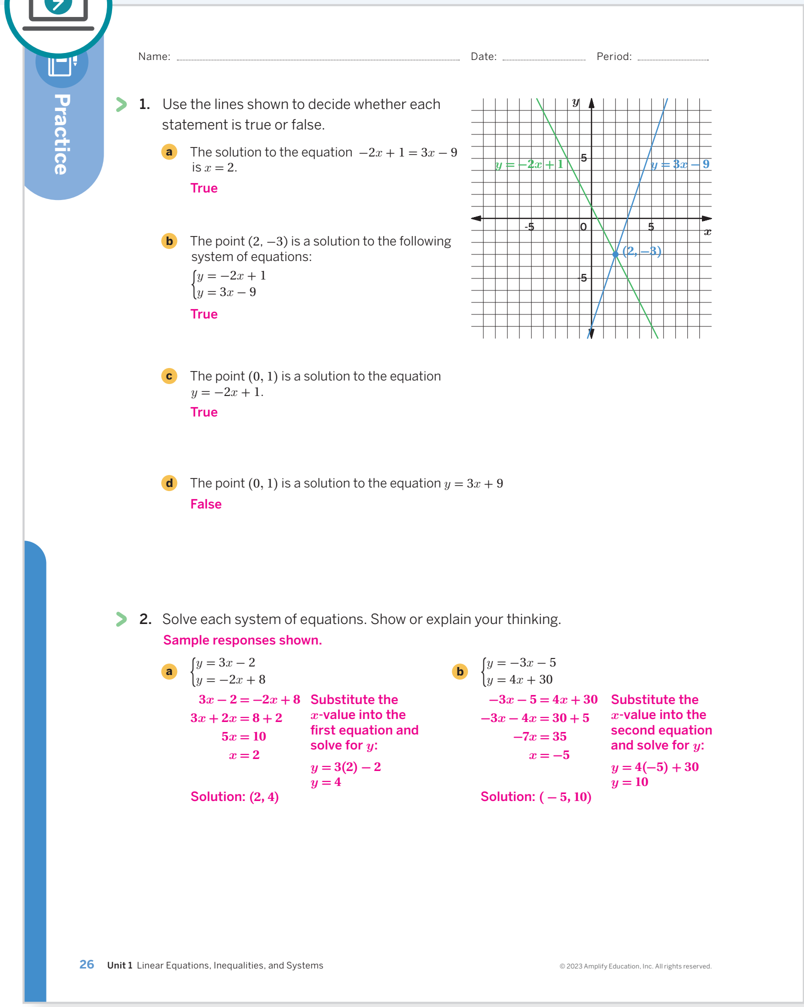
This professional learning moment is designed to be completed independently or collaboratively with your fellow mathematics educators. Prompts are provided so that you can reflect on this lesson before moving on to the next lesson.

Points to Ponder . . .

- What worked and didn't work today? During the discussion in the Warm-up, how did you encourage each student to listen to one another's strategies?
- What challenges did students encounter as they worked on Activity 1? What might you change for the next time you teach this lesson?

Practice

Independent



Practice

Name: ______ Date: ______ Period: ______

1. Use the lines shown to decide whether each statement is true or false.

a The solution to the equation $-2x + 1 = 3x - 9$ is $x = 2$.

True

b The point $(2, -3)$ is a solution to the following system of equations:

$$\begin{cases} y = -2x + 1 \\ y = 3x - 9 \end{cases}$$

True

c The point $(0, 1)$ is a solution to the equation $y = -2x + 1$.

True

d The point $(0, 1)$ is a solution to the equation $y = 3x + 9$

False

2. Solve each system of equations. Show or explain your thinking.

Sample responses shown.

a $\begin{cases} y = 3x - 2 \\ y = -2x + 8 \end{cases}$

$3x - 2 = -2x + 8$

$3x + 2x = 8 + 2$

$5x = 10$

$x = 2$

Substitute the x-value into the first equation and solve for y:

$y = 3(2) - 2$

$y = 4$

Solution: $(2, 4)$

b $\begin{cases} y = -3x - 5 \\ y = 4x + 30 \end{cases}$

$-3x - 5 = 4x + 30$

$-3x - 4x = 30 + 5$

$-7x = 35$

$x = -5$

Substitute the x-value into the second equation and solve for y:

$y = 4(-5) + 30$

$y = 10$

Solution: $(-5, 10)$

26 **Unit 1** Linear Equations, Inequalities, and Systems

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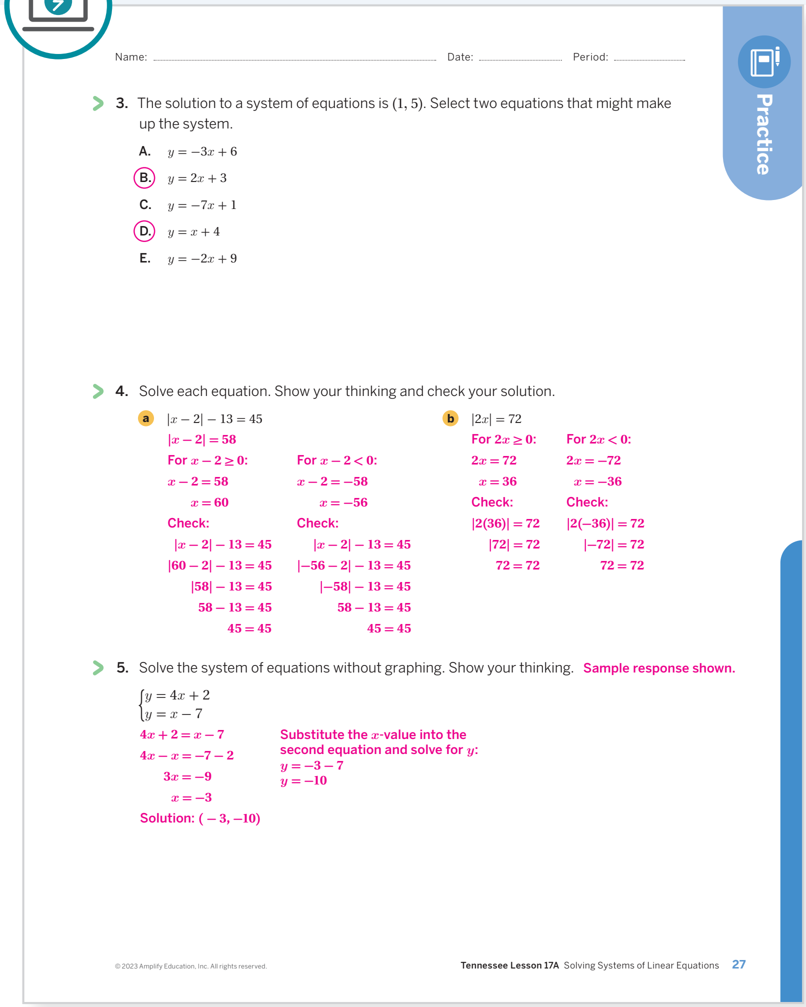

Practice

Name: ______ Date: ______ Period: ______

3. The solution to a system of equations is $(1, 5)$. Select two equations that might make up the system.

A. $y = -3x + 6$

[✓ B.] $y = 2x + 3$

C. $y = -7x + 1$

[✓ D.] $y = x + 4$

E. $y = -2x + 9$

4. Solve each equation. Show your thinking and check your solution.

a $|x - 2| - 13 = 45$

$|x - 2| = 58$

For $x - 2 \geq 0$:

$x - 2 = 58$

$x = 60$

Check:

$|x - 2| - 13 = 45$

$|60 - 2| - 13 = 45$

$|58| - 13 = 45$

$58 - 13 = 45$

$45 = 45$

For $x - 2 < 0$:

$x - 2 = -58$

$x = -56$

Check:

$|x - 2| - 13 = 45$

$|-56 - 2| - 13 = 45$

$|-58| - 13 = 45$

$58 - 13 = 45$

$45 = 45$

b $|2x| = 72$

For $2x \geq 0$:

$2x = 72$

$x = 36$

Check:

$|2(36)| = 72$

$|72| = 72$

$72 = 72$

For $2x < 0$:

$2x = -72$

$x = -36$

Check:

$|2(-36)| = 72$

$|-72| = 72$

$72 = 72$

5. Solve the system of equations without graphing. Show your thinking. **Sample response shown.**

$$\begin{cases} y = 4x + 2 \\ y = x - 7 \end{cases}$$

$4x + 2 = x - 7$

$4x - x = -7 - 2$

$3x = -9$

$x = -3$

Substitute the x-value into the second equation and solve for y:

$y = -3 - 7$

$y = -10$

Solution: $(-3, -10)$

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Tennessee Lesson 17A Solving Systems of Linear Equations 27

Practice Problem Analysis

Type	Problem	Refer to	Standard(s)	DOK
On-lesson	1	Activity 1	A1.A.REI.C.4	2
	2	Activity 2	A1.A.REI.C.4	2
	3	Activities 1 and 2	A1.A.REI.C.4	2
Spiral	4	Unit 1 Tennessee Lesson 12B	A1.A.REI.B.2b	2
Formative ⚡	5	Unit 1 Lesson 18	A1.A.REI.C	2

⚡ **Power-up:** If students need additional support with the key prerequisite concept or skill this problem addresses, consider assigning the Power-up in the next lesson.

Additional Practice Available

For students who need additional practice in this lesson, assign the **Algebra 1 Additional Practice**.

Operations With Polynomials

Let's add, subtract, and multiply polynomials.

Focus

Goals

1. **Language Goal:** Reason about the sums, differences, and products of polynomials. **(Speaking and Listening, Writing)**
2. Write a polynomial in standard form and identify its degree, leading term, and constant term.
3. **Language Goal:** Comprehend that when polynomials are combined by addition, subtraction, or multiplication, the result is a polynomial. **(Reading and Writing, and Speaking and Listening)**

Coherence

Today

Students are introduced to *polynomials*. They learn that polynomials can be written in *standard form* to help identify the *leading coefficient* and *degree* of the polynomial. Students reason about the sums, differences, and products of polynomials **(MP7)** and experiment with these operations to determine whether polynomials are closed under addition, subtraction, and multiplication **(MP8)**.

Previously

In Lesson 11, students used area diagrams and algebra tiles to visualize the multiplication of two linear terms.

Coming Soon

In Lesson 12, students will formally define two forms of quadratics – *standard form* and *factored form*. They will transition from using area diagrams to multiplying the terms in each factor of a quadratic expression written in factored form.

Rigor

- Students build **conceptual understanding** of operations with polynomials.
- Students build **procedural fluency** of adding, subtracting, and multiplying polynomials.

Standards

Addressing

A1.A.APR.A.1
Add, subtract, and multiply polynomials. Use these operations to demonstrate that polynomials form a closed system that adhere to the same properties of operations as the integers.

Also Addressing: **A1.A.SSE.A.1a**

Pacing Guide

Suggested Total Lesson Time ~**50 min**

Warm-up	Activity 1	Activity 2	Activity 3	Summary	Exit Ticket
5 min	15 min	10 min	10 min	5 min	5 min
Pairs	Pairs	Pairs	Pairs	Whole Class	Independent
MP7	MP3	MP7	MP8		
A1.A.APR.A.1, A1.A.SSE.A.1a	A1.A.APR.A.1	A1.A.APR.A.1, A1.A.SSE.A.1a	A1.A.APR.A.1	A1.A.APR.A.1	A1.A.APR.A.1, A1.A.SSE.A.1a

Amps powered by desmos | Activity and Presentation Slides

For a digitally interactive experience of this lesson, log in to Amplify Math at **learning.amplify.com**.

Practice

Independent

Materials

- Exit Ticket
- Additional Practice
- Warm-up PDF, *Parts of a Polynomial* (for display)
- Anchor Chart PDF, *Sentence Stems, Critiquing* (as needed)
- Anchor Chart PDF, *Sentence Stems, Stronger and Clearer Each Time* (as needed)
- colored pencils (as needed)

Math Language Development

New words

- ***degree***
- ***leading coefficient***
- ***polynomial***
- ***standard form***

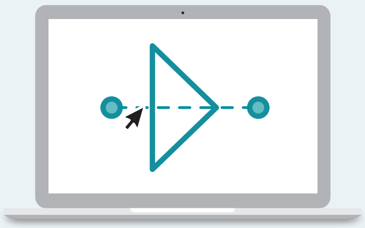
Review words

- *area diagram*
- *coefficient*
- *constant term*
- *Distributive Property*
- *like terms*

Amps | Featured Activity

Activity 2
Digital Area Diagrams

Students use digital area diagrams to multiply polynomials.



Building Math Identity and Community

Connecting to Mathematical Practices

Students may feel frustrated or overwhelmed when determining which student is correct in Activity 1 **(MP3)**. Encourage students to reflect and write down what they notice about each problem before they critique the reasoning of others. Remind them to check in with their peers to help construct viable arguments.

Modifications to Pacing

You may want to consider these additional modifications if you are short on time.

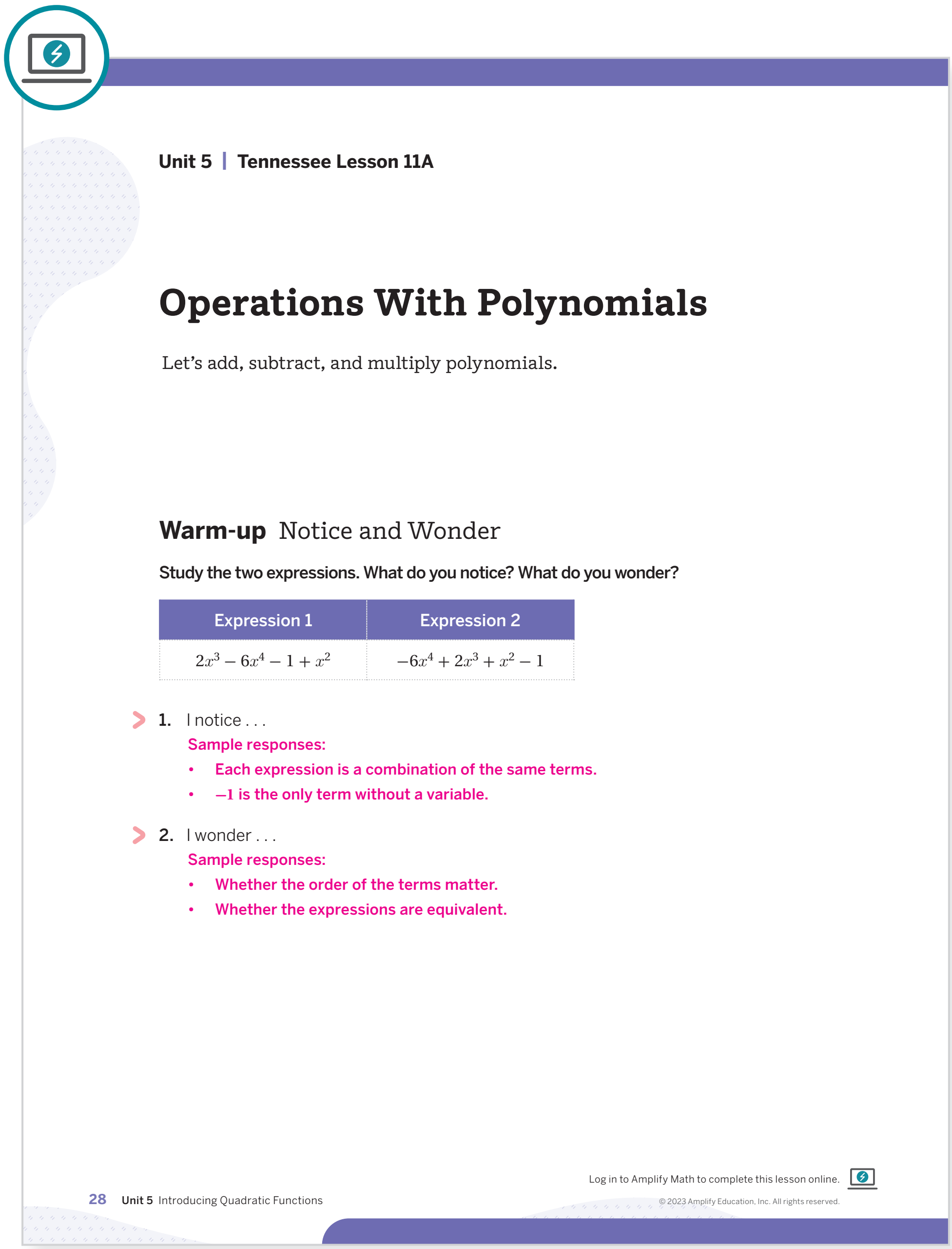
- In **Activity 1**, Problem 3 may be assigned as additional practice.
- In **Activity 2**, Problems 3 and 4 may be omitted.
- In **Activity 3**, provide students with polynomials to add, subtract, or multiply.

Pairs | 5 min

MP7
A1.A.APR.A.1, A1.A.SSE.A.1a

Warm-up Notice and Wonder

Students compare expressions to learn about polynomials and standard form.



Unit 5 | **Tennessee Lesson 11A**

Operations With Polynomials

Let's add, subtract, and multiply polynomials.

Warm-up Notice and Wonder

Study the two expressions. What do you notice? What do you wonder?

Expression 1	Expression 2
$2x^3 - 6x^4 - 1 + x^2$	$-6x^4 + 2x^3 + x^2 - 1$

1. I notice . . .

Sample responses:
- **Each expression is a combination of the same terms.**
- **-1 is the only term without a variable.**

2. I wonder . . .

Sample responses:
- **Whether the order of the terms matter.**
- **Whether the expressions are equivalent.**

Log in to Amplify Math to complete this lesson online.

28 **Unit 5** Introducing Quadratic Functions

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1 Launch

Conduct the ***Notice and Wonder*** routine.

2 Monitor

Help students get started by having them examine the coefficients and exponents in each expression.

Look for productive strategies:

- Noticing the expressions are equivalent **(MP7)**.
- Using vocabulary, such as *coefficients* and *exponents* to describe what they notice and wonder.

3 Connect

Have students share their responses.

Display the Warm-up PDF.

Define the term ***polynomial*** as a function or expression that is a sum of terms, each of which is a product of a constant and variable raised to a whole number power. A polynomial is written in ***standard form*** when all the terms are ordered from greatest exponent to least exponent. The ***degree*** of a polynomial is the greatest exponent on a variable in the polynomial. The ***leading coefficient*** is the coefficient of the term with the greatest exponent. Remind students that the *constant term* is a value that does change, and does not contain a variable.

Highlight that Expressions 1 and 2 are equivalent, but Expression 2 is a polynomial written in standard form. Also highlight that -1 is the constant term in both expressions.

Ask, "Why might it be helpful to write a polynomial in standard form?" Sample response: It could be easier to identify the leading coefficient and the degree of the polynomial or to check whether two polynomials are equivalent.

Power-up

To power up students' ability to expand quadratic expressions that are written in factored form, have students complete:

Draw an area model and write an equivalent expression for $(x + 5)(x + 7)$.
Sample response:

$x^2 + 12x + 35$

	x	5
x	x^2	$5x$
7	$7x$	35

Use: Before Activity 2

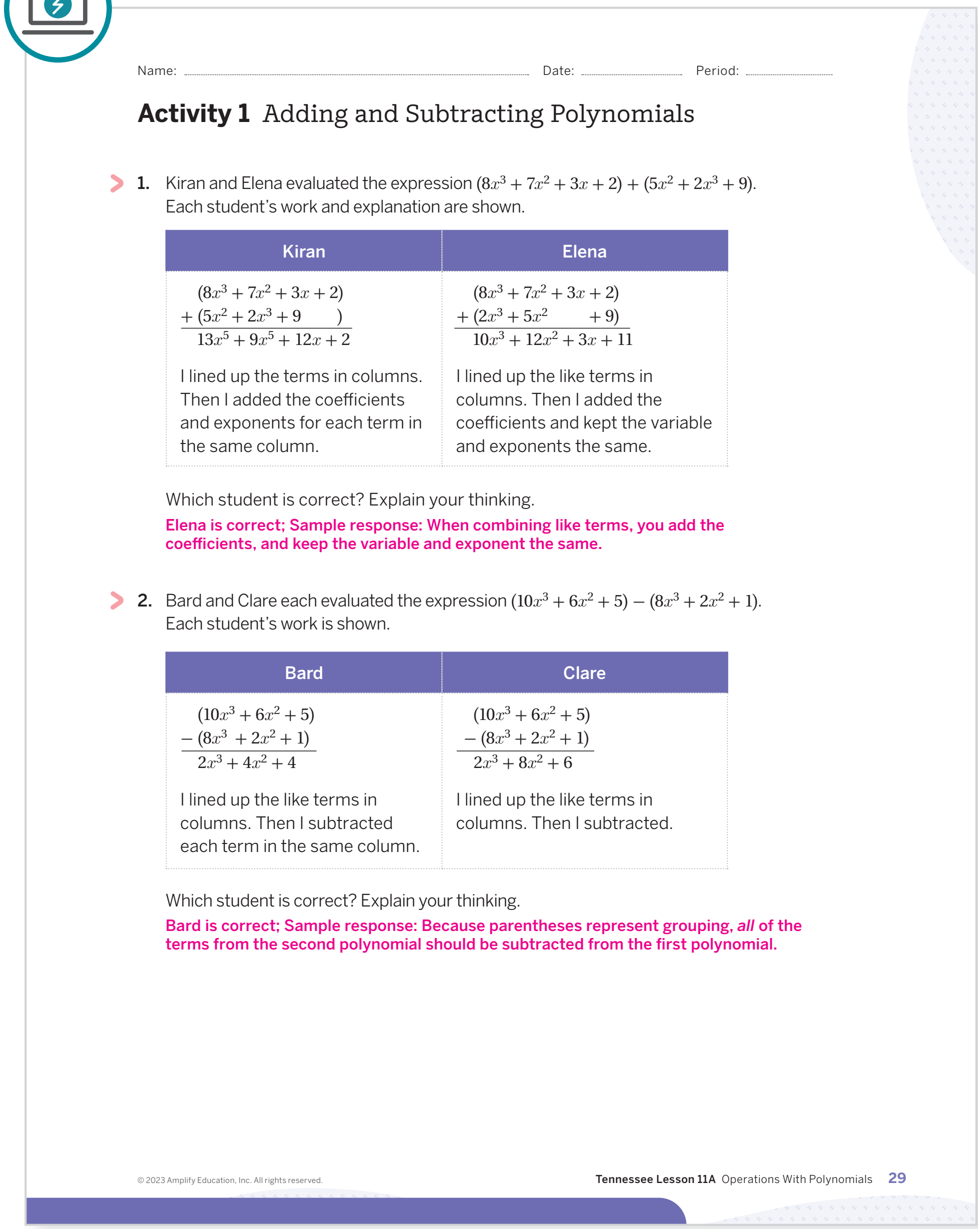
Informed by: Performance on Lesson 11, Practice Problem 6

Pairs | 15 min

MP3
A1.A.APR.A.1

Activity 1 Adding and Subtracting Polynomials

Students critique the reasoning of others to understand how to add and subtract polynomials **(MP3).**



Name: ______ Date: ______ Period: ______

Activity 1 Adding and Subtracting Polynomials

1. Kiran and Elena evaluated the expression $(8x^3 + 7x^2 + 3x + 2) + (5x^2 + 2x^3 + 9)$. Each student's work and explanation are shown.

Kiran	Elena
$\begin{array}{r} (8x^3 + 7x^2 + 3x + 2) \\ + (5x^2 + 2x^3 + 9 \qquad) \\ \hline 13x^5 + 9x^5 + 12x + 2 \end{array}$	$\begin{array}{r} (8x^3 + 7x^2 + 3x + 2) \\ + (2x^3 + 5x^2 \qquad + 9) \\ \hline 10x^3 + 12x^2 + 3x + 11 \end{array}$
I lined up the terms in columns. Then I added the coefficients and exponents for each term in the same column.	I lined up the like terms in columns. Then I added the coefficients and kept the variable and exponents the same.

Which student is correct? Explain your thinking.

Elena is correct; Sample response: When combining like terms, you add the coefficients, and keep the variable and exponent the same.

2. Bard and Clare each evaluated the expression $(10x^3 + 6x^2 + 5) - (8x^3 + 2x^2 + 1)$. Each student's work is shown.

Bard	Clare
$\begin{array}{r} (10x^3 + 6x^2 + 5) \\ - (8x^3 + 2x^2 + 1) \\ \hline 2x^3 + 4x^2 + 4 \end{array}$	$\begin{array}{r} (10x^3 + 6x^2 + 5) \\ - (8x^3 + 2x^2 + 1) \\ \hline 2x^3 + 8x^2 + 6 \end{array}$
I lined up the like terms in columns. Then I subtracted each term in the same column.	I lined up the like terms in columns. Then I subtracted.

Which student is correct? Explain your thinking.

Bard is correct; Sample response: Because parentheses represent grouping, *all* of the terms from the second polynomial should be subtracted from the first polynomial.

1 Launch

Have students complete Problems 1–2 individually. Then have them share responses with a partner before completing Problem 3.

2 Monitor

Help students get started by reviewing how Kiran and Elena each arrived at their answers.

Look for points of confusion:

- **Thinking that Kiran is correct.** Remind students that terms with different powers of x cannot be added. Consider relating x^3 to apples and x^2 to bananas; they are not like terms and cannot be combined.
- **Thinking that Clare is correct.** Remind students that the negative sign can be distributed to each term inside the parentheses.
- **For Problem 3d, misunderstanding x^2 as $0x^2$ because they do not see a coefficient.** Tell students that $x^2 = 1x^2$ and have them write a 1 for the coefficient.

Look for productive strategies:

- For Problem 3, rewriting polynomials in standard form before matching each to an equivalent expression.

Activity 1 continued ›

Differentiated Support

Accessibility: *Guide Processing and Visualization*

Distribute colored pencils and suggest that students color code the like terms using different colors.

Math Language Development

MLR7: Compare and Connect

During the Connect, as students share their responses for Problems 1 and 2, draw connections between Elena's and Bard's responses. Ask:

- "What do you notice that is similar about each person's work?"
- "What do you notice that is different about each person's work?"

English Learners

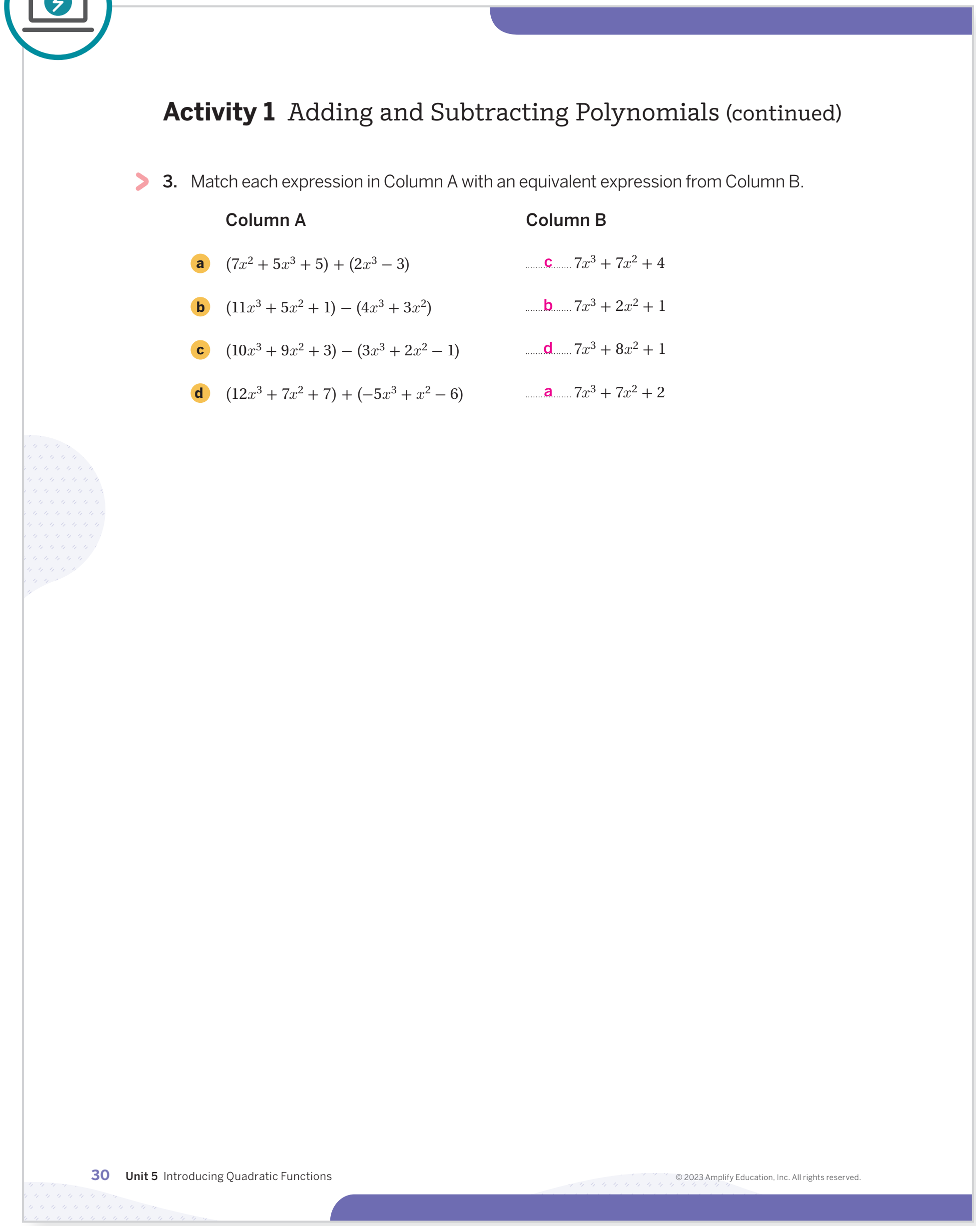
Display or provide access to the Anchor Chart PDF, *Sentence Stems, Critiquing*.

Pairs | 15 min

MP3
A1.A.APR.A.1

Activity 1 Adding and Subtracting Polynomials (continued)

Students critique the reasoning of others to understand how to add and subtract polynomials **(MP3).**



Activity 1 Adding and Subtracting Polynomials (continued)

3. Match each expression in Column A with an equivalent expression from Column B.

Column A	**Column B**
a $(7x^2 + 5x^3 + 5) + (2x^3 - 3)$	c $7x^3 + 7x^2 + 4$
b $(11x^3 + 5x^2 + 1) - (4x^3 + 3x^2)$	b $7x^3 + 2x^2 + 1$
c $(10x^3 + 9x^2 + 3) - (3x^3 + 2x^2 - 1)$	d $7x^3 + 8x^2 + 1$
d $(12x^3 + 7x^2 + 7) + (-5x^3 + x^2 - 6)$	a $7x^3 + 7x^2 + 2$

30 **Unit 5** Introducing Quadratic Functions

3 Connect

Have students share their strategies for determining which students were correct for Problems 1 and 2.

Display student work showing the matches for Problem 3. Have students share their strategies for matching the equivalent expressions. Select students who distributed the negative sign before combining like terms and students who rewrote polynomials in standard form to determine matches.

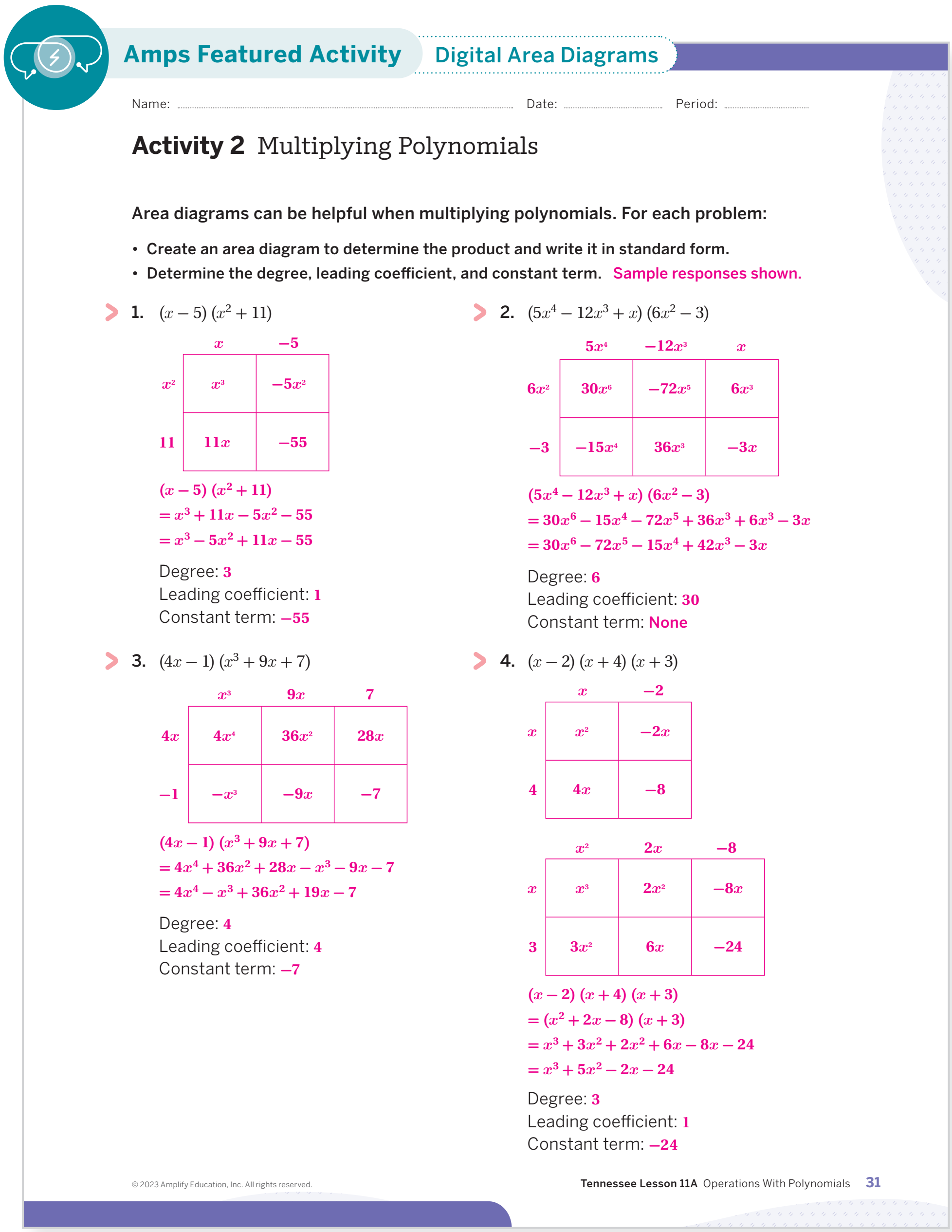
Highlight that when adding and subtracting polynomials, students can combine terms with the same variable and exponent. Remind students that when subtracting polynomials, *every* term in the polynomial should be subtracted.

Pairs | 10 min

Activity 2 Multiplying Polynomials

MP7
A1.A.APR.A.1, A1.A.SSE.A.1a

Students create area diagrams to help reason about multiplying polynomials and to write the product in standard form.



Amps Featured Activity Digital Area Diagrams

Name: Date: Period:

Activity 2 Multiplying Polynomials

Area diagrams can be helpful when multiplying polynomials. For each problem:

- Create an area diagram to determine the product and write it in standard form.
- Determine the degree, leading coefficient, and constant term. Sample responses shown.

1. $(x-5)(x^2+11)$

	x	-5
x^2	x^3	$-5x^2$
11	$11x$	-55

$(x-5)(x^2+11)$
$= x^3+11x-5x^2-55$
$= x^3-5x^2+11x-55$

Degree: 3
Leading coefficient: 1
Constant term: −55

2. $(5x^4-12x^3+x)(6x^2-3)$

	$5x^4$	$-12x^3$	x
$6x^2$	$30x^6$	$-72x^5$	$6x^3$
-3	$-15x^4$	$36x^3$	$-3x$

$(5x^4-12x^3+x)(6x^2-3)$
$= 30x^6-15x^4-72x^5+36x^3+6x^3-3x$
$= 30x^6-72x^5-15x^4+42x^3-3x$

Degree: 6
Leading coefficient: 30
Constant term: None

3. $(4x-1)(x^3+9x+7)$

	x^3	$9x$	7
$4x$	$4x^4$	$36x^2$	$28x$
-1	$-x^3$	$-9x$	-7

$(4x-1)(x^3+9x+7)$
$= 4x^4+36x^2+28x-x^3-9x-7$
$= 4x^4-x^3+36x^2+19x-7$

Degree: 4
Leading coefficient: 4
Constant term: −7

4. $(x-2)(x+4)(x+3)$

	x	-2
x	x^2	$-2x$
4	$4x$	-8

	x^2	$2x$	-8
x	x^3	$2x^2$	$-8x$
3	$3x^2$	$6x$	-24

$(x-2)(x+4)(x+3)$
$= (x^2+2x-8)(x+3)$
$= x^3+3x^2+2x^2+6x-8x-24$
$= x^3+5x^2-2x-24$

Degree: 3
Leading coefficient: 1
Constant term: −24

Tennessee Lesson 11A Operations With Polynomials 31

1 Launch

Have students complete Problems 1—3, and assign Problem 4 based on student readiness.

2 Monitor

Help students get started by modeling how to write the sides of an area diagram and calculate a term inside the diagram.

Look for points of confusion:

- **Not combining like terms for Problems 2—4.** Confirm that the product is correct, but remind students that like terms can be combined.
- **Multiply the exponents.** Remind students of the Product rule $a^m \cdot a^n = a^{m+n}$.
- **Struggling to organize work in Problem 4.** Have students use an area diagram to multiply the first two factors. Once they determine the product, ask, "How can you use another diagram to determine the product of *all three* factors?"

Look for productive strategies:

- Annotating the area diagram to multiply and combine like terms.
- Understanding how to write the expression in standard form without using an area diagram.

3 Connect

Have students share the strategy they used to determine each product. Select any students that applied the Distributive Property when determining their response.

Display the area diagrams that students used to solve Problem 4.

Ask "What property allows you to use the area diagram to multiply?"

Highlight that the area diagrams provide a visual representation of the Distributive Property. Each term in the first factor is multiplied by each term in the second factor. This pattern is extended when multiplying three or more factors **(MP7)**.

Differentiated Support

Accessibility: *Optimize Access to Technology*

Have students use the Amps slides for this activity, in which they can use digital area diagrams to multiply a polynomial by a polynomial.

Accessibility: *Guide Processing and Visualization, Vary Demands to Optimize Challenge*

Consider providing blank area diagrams for students to complete. If students need more processing time, have them focus on completing Problems 1—3, and only work on Problems 4—5 if they have time available.

Extension: *Math Enrichment*

Have students complete the following problem:

Write the polynomial $2x^2+x-45$ as a product of two factors by creating an area diagram.

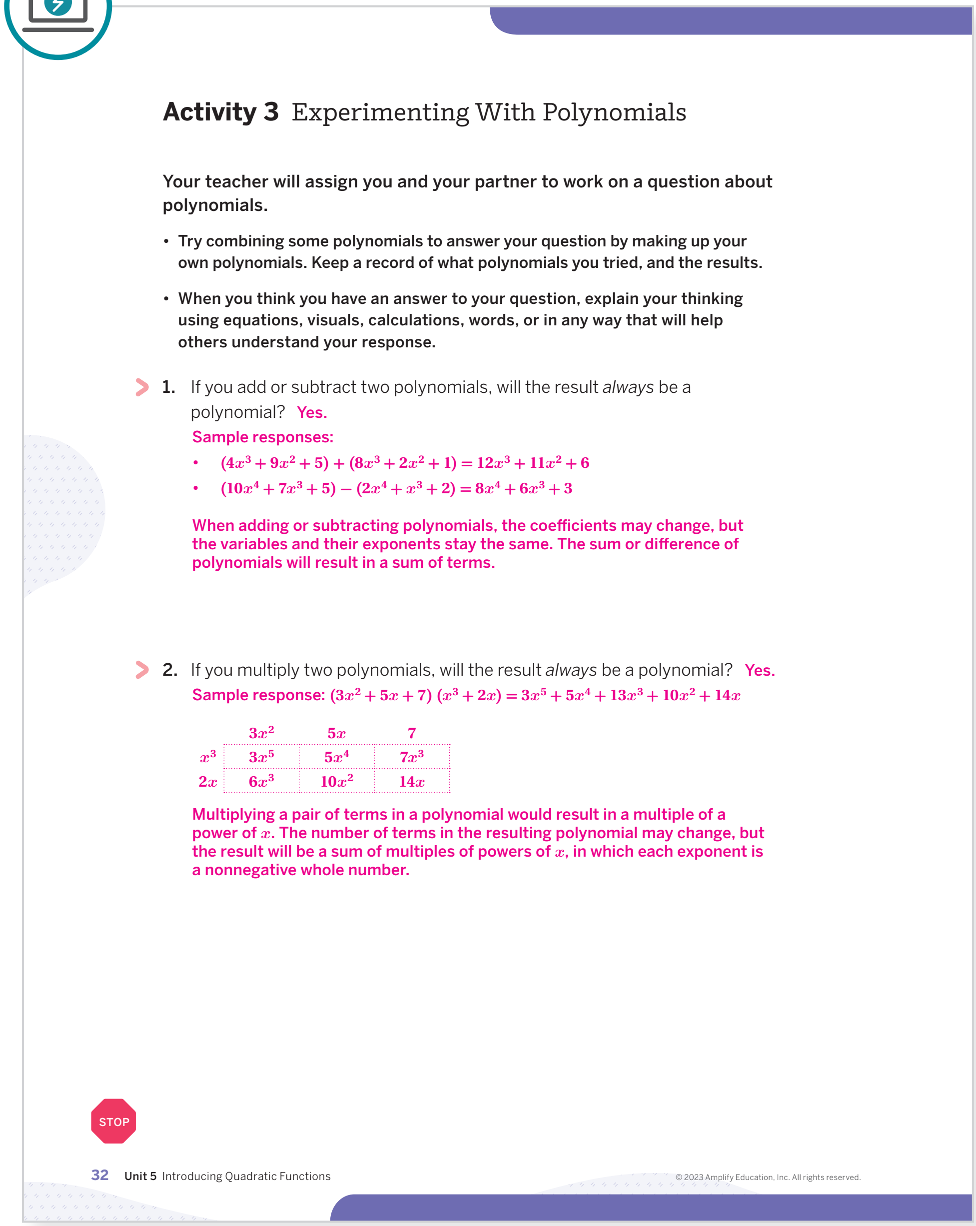
Sample response: $(2x-9)(x+5)$

Pairs | 10 min

Activity 3 Experimenting With Polynomials

MP8
A1.A.APR.A.1

Students experiment with adding, subtracting, and multiplying polynomials to see that polynomials are closed under these operations **(MP8).**



Activity 3 Experimenting With Polynomials

Your teacher will assign you and your partner to work on a question about polynomials.

- **Try combining some polynomials to answer your question by making up your own polynomials. Keep a record of what polynomials you tried, and the results.**
- **When you think you have an answer to your question, explain your thinking using equations, visuals, calculations, words, or in any way that will help others understand your response.**

1. If you add or subtract two polynomials, will the result *always* be a polynomial? **Yes.**

Sample responses:

- $(4x^3+9x^2+5)+(8x^3+2x^2+1)=12x^3+11x^2+6$
- $(10x^4+7x^3+5)-(2x^4+x^3+2)=8x^4+6x^3+3$

When adding or subtracting polynomials, the coefficients may change, but the variables and their exponents stay the same. The sum or difference of polynomials will result in a sum of terms.

2. If you multiply two polynomials, will the result *always* be a polynomial? **Yes.**

Sample response: $(3x^2+5x+7)\,(x^3+2x)=3x^5+5x^4+13x^3+10x^2+14x$

	$3x^2$	$5x$	7
x^3	$3x^5$	$5x^4$	$7x^3$
$2x$	$6x^3$	$10x^2$	$14x$

Multiplying a pair of terms in a polynomial would result in a multiple of a power of x. The number of terms in the resulting polynomial may change, but the result will be a sum of multiples of powers of x, in which each exponent is a nonnegative whole number.

STOP

32 **Unit 5** Introducing Quadratic Functions

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1 Launch

Write and display several whole numbers. Ask, “If you add/subtract/multiply two whole numbers is the result *always* a whole number?” Tell students they will investigate whether adding, subtracting, and multiplying two polynomials will always result in a polynomial. Assign pairs of students to complete either Problem 1 or Problem 2.

2 Monitor

Help students get started by having students write two polynomials to add, subtract, or multiply.

Look for points of confusion:

- **Using expressions that are not polynomials.** Remind students of the definition of a polynomial. Have them rephrase the definition in their own words and check the expressions they used.

Look for productive strategies:

- Experimenting with a variety of polynomials, including: monomials, binomials, trinomials, and other polynomials with a variety of degrees.

3 Connect

Have pairs of students share their responses. Select students who answered Problem 1 and Problem 2. Have students share their strategies for determining their responses.

Ask, “Does $(5x^3+4x^2+9)-(5x^3+4x^2+7)$ result in a polynomial?” Yes. The result is 2, a constant term which has a degree of 0.

Highlight that polynomials are closed under addition, subtraction, and multiplication. This means that if polynomials are added, subtracted or multiplied together, the result is always a polynomial.

Differentiated Support

Accessibility: *Guide Processing and Visualization*

Provide students with four different polynomials with varying coefficients and exponents. Have students select different pairs of polynomials to add, subtract, or multiply.

Math Language Development

MLR1: Stronger and Clearer Each Time

After students complete Problems 1 or 2, have pairs meet with 1–2 other pairs of students to share their responses. Encourage reviewers to ask clarifying questions such as:

- “What is the same and what is different between each method?”
- “Is the result *always* the same when adding, subtracting, or multiplying polynomials?”
- “What does this tell you about adding, subtracting, or multiplying polynomials?”

Have students revise their responses, as needed.

English Learners

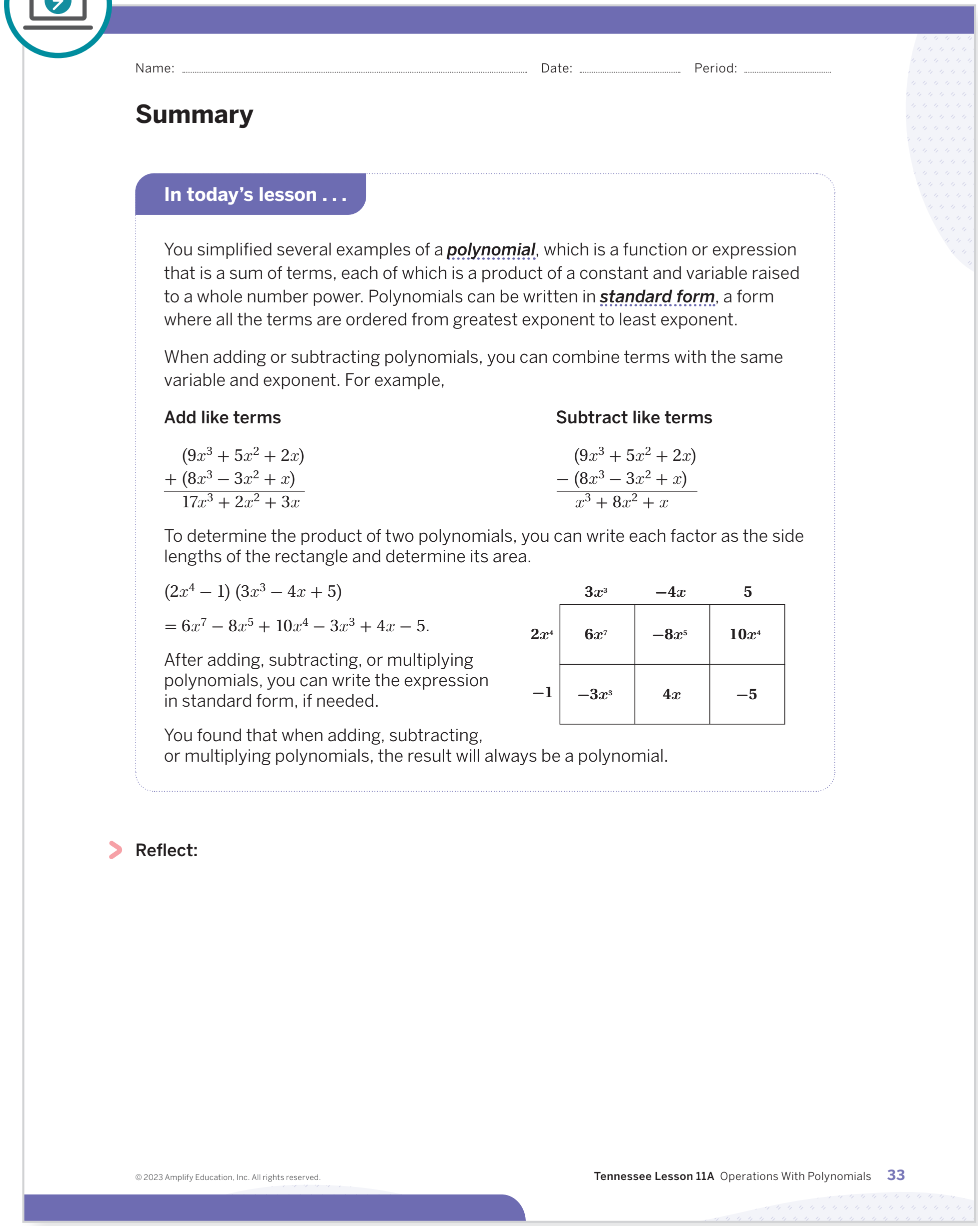
Display or provide access to the Anchor Chart PDF, *Sentence Stems*, *Stronger and Clearer Each Time*.

Whole Class | 5 min

Summary

A1.A.APR.A.1

Review and synthesize adding, subtracting, and multiplying polynomials.



Name: ______ Date: ______ Period: ______

Summary

In today's lesson . . .

You simplified several examples of a ***polynomial***, which is a function or expression that is a sum of terms, each of which is a product of a constant and variable raised to a whole number power. Polynomials can be written in ***standard form***, a form where all the terms are ordered from greatest exponent to least exponent.

When adding or subtracting polynomials, you can combine terms with the same variable and exponent. For example,

Add like terms

$$\begin{array}{r} (9x^3 + 5x^2 + 2x) \\ +\ (8x^3 - 3x^2 + x) \\ \hline 17x^3 + 2x^2 + 3x \end{array}$$

Subtract like terms

$$\begin{array}{r} (9x^3 + 5x^2 + 2x) \\ -\ (8x^3 - 3x^2 + x) \\ \hline x^3 + 8x^2 + x \end{array}$$

To determine the product of two polynomials, you can write each factor as the side lengths of the rectangle and determine its area.

$(2x^4 - 1)\ (3x^3 - 4x + 5)$

$= 6x^7 - 8x^5 + 10x^4 - 3x^3 + 4x - 5.$

	$3x^3$	$-4x$	5
$2x^4$	$6x^7$	$-8x^5$	$10x^4$
-1	$-3x^3$	$4x$	-5

After adding, subtracting, or multiplying polynomials, you can write the expression in standard form, if needed.

You found that when adding, subtracting, or multiplying polynomials, the result will always be a polynomial.

Reflect:

Synthesize

Display the Summary.

Ask, "How are adding, subtracting, and multiplying polynomials similar? How are they different?"

Have students share how they can write a polynomial in standard form and how they can identify a polynomial's leading coefficient and degree.

Highlight

- When adding and subtracting polynomials, students can combine terms with the same variable and exponent.
- When multiplying monomials by polynomials, *every* term from *each* factor should be multiplied.
- Polynomials are closed under addition, subtraction, and multiplication.

Formalize vocabulary:

- ***degree***
- ***leading coefficient***
- ***polynomial***
- ***standard form***

Reflect

After synthesizing the concepts of the lesson, allow students a few moments for reflection. Encourage them to record any notes in the *Reflect* space provided in the Student Edition. To help them engage in meaningful reflection, consider asking:

- "What strategies did you find helpful when adding, subtracting, and multiplying polynomials?"

Math Language Development

MLR2: Collect and Display

As students formalize the new vocabulary for this lesson, ask them to refer to the class display that you started in this unit. Ask them to review and reflect on any terms and phrases related to the terms *degree*, *leading coefficient*, *polynomial*, and *standard form* that were added to the display during the lesson.

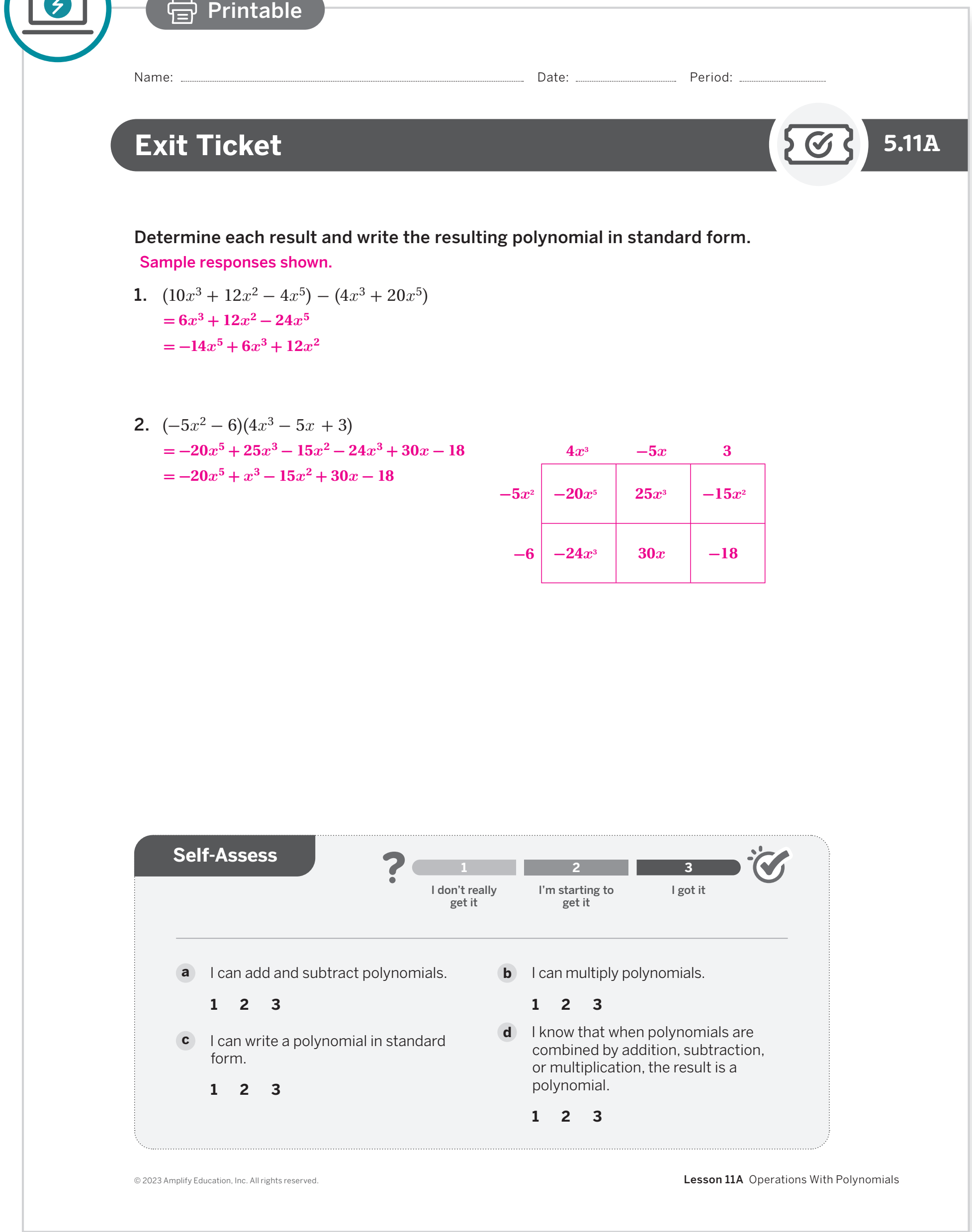
Independent | 5 min

Exit Ticket

A1.A.APR.A.1, A1.A.SSE.A.1a

Students demonstrate their understanding by subtracting and multiplying polynomials.

Printable



Name: Date: Period:

Exit Ticket

5.11A

Determine each result and write the resulting polynomial in standard form.

Sample responses shown.

1. $(10x^3 + 12x^2 - 4x^5) - (4x^3 + 20x^5)$

$= 6x^3 + 12x^2 - 24x^5$

$= -14x^5 + 6x^3 + 12x^2$

2. $(-5x^2 - 6)(4x^3 - 5x + 3)$

$= -20x^5 + 25x^3 - 15x^2 - 24x^3 + 30x - 18$

$= -20x^5 + x^3 - 15x^2 + 30x - 18$

	$4x^3$	$-5x$	3
$-5x^2$	$-20x^5$	$25x^3$	$-15x^2$
-6	$-24x^3$	$30x$	-18

Self-Assess

? 1 I don't really get it | 2 I'm starting to get it | 3 I got it

a I can add and subtract polynomials.

1 2 3

b I can multiply polynomials.

1 2 3

c I can write a polynomial in standard form.

1 2 3

d I know that when polynomials are combined by addition, subtraction, or multiplication, the result is a polynomial.

1 2 3

Lesson 11A Operations With Polynomials

Success looks like . . .

- **Language Goal:** Reasoning about the sums, differences, and products of polynomials. **(Speaking and Listening, Writing)**
  - » Remembering to subtract $4x^3$ and $20x^5$ in Problem 1.
  - » Drawing an area diagram to determine the product in Problem 2.
- **Goal:** Writing a polynomial in standard form and identifying its degree, leading term, and constant term.
  - » Correctly writing both problems in standard form.
- **Language Goal:** Comprehending that when polynomials are combined by addition, subtraction, or multiplication, the result is a polynomial. **(Speaking and Listening, Writing)**

Suggested next steps

If students do not correctly write the difference of Problem 1 in standard form, consider:

- Having them distribute the negative.
- Rewriting the problem vertically and lining up the like terms before simplifying.
- Reviewing Activity 1.

If students do not correctly write the product of Problem 2 in standard form, consider:

- Having them draw an area diagram.
- Reviewing Activity 2.

Professional Learning

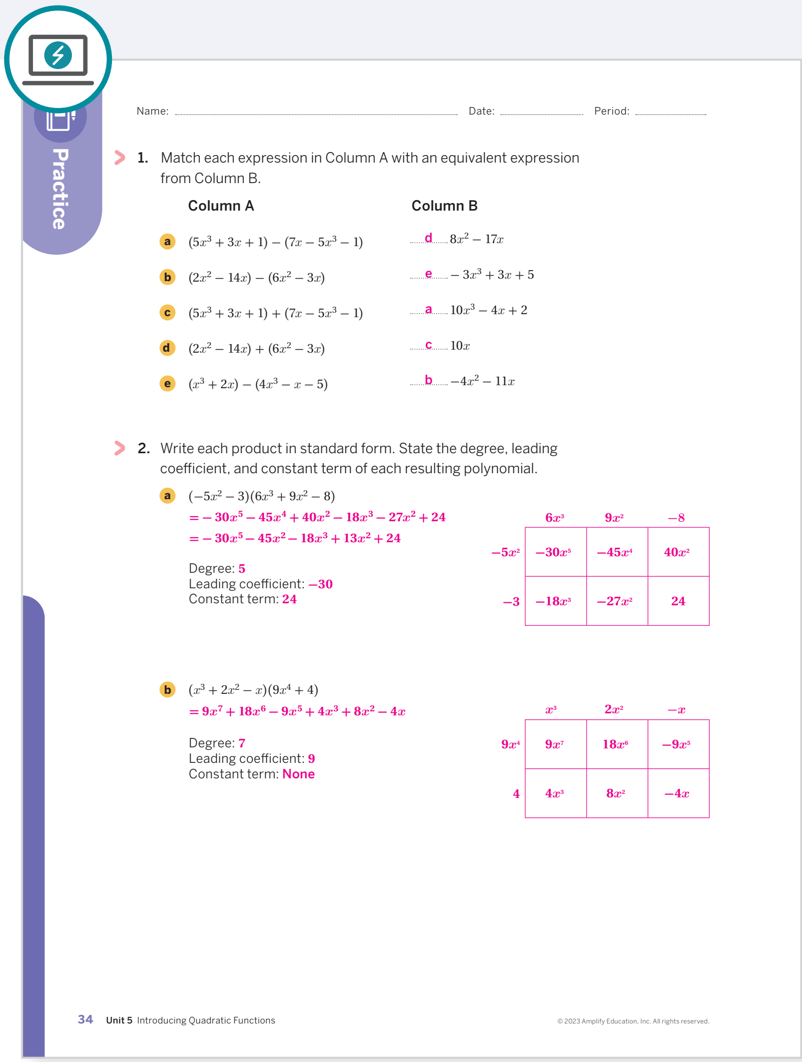
This professional learning moment is designed to be completed independently or collaboratively with your fellow mathematics educators. Prompts are provided so that you can reflect on this lesson before moving on to the next lesson.

Points to Ponder . . .

- What worked and didn't work today? In earlier lessons, students found the product of two binomials. How did that support students as they multiplied two polynomials today?
- What challenges did students encounter as they worked on Activity 3? How did they work through them? What might you change for the next time you teach this lesson?

Practice

Independent



Name: Date: Period:

Practice

1. Match each expression in Column A with an equivalent expression from Column B.

Column A	Column B
a $(5x^3 + 3x + 1) - (7x - 5x^3 - 1)$	d $8x^2 - 17x$
b $(2x^2 - 14x) - (6x^2 - 3x)$	e $-3x^3 + 3x + 5$
c $(5x^3 + 3x + 1) + (7x - 5x^3 - 1)$	a $10x^3 - 4x + 2$
d $(2x^2 - 14x) + (6x^2 - 3x)$	c $10x$
e $(x^3 + 2x) - (4x^3 - x - 5)$	b $-4x^2 - 11x$

2. Write each product in standard form. State the degree, leading coefficient, and constant term of each resulting polynomial.

a $(-5x^2 - 3)(6x^3 + 9x^2 - 8)$

$= -30x^5 - 45x^4 + 40x^2 - 18x^3 - 27x^2 + 24$

$= -30x^5 - 45x^2 - 18x^3 + 13x^2 + 24$

Degree: 5
Leading coefficient: −30
Constant term: 24

	$6x^3$	$9x^2$	-8
$-5x^2$	$-30x^5$	$-45x^4$	$40x^2$
-3	$-18x^3$	$-27x^2$	24

b $(x^3 + 2x^2 - x)(9x^4 + 4)$

$= 9x^7 + 18x^6 - 9x^5 + 4x^3 + 8x^2 - 4x$

Degree: 7
Leading coefficient: 9
Constant term: None

	x^3	$2x^2$	$-x$
$9x^4$	$9x^7$	$18x^6$	$-9x^5$
4	$4x^3$	$8x^2$	$-4x$

34 **Unit 5** Introducing Quadratic Functions

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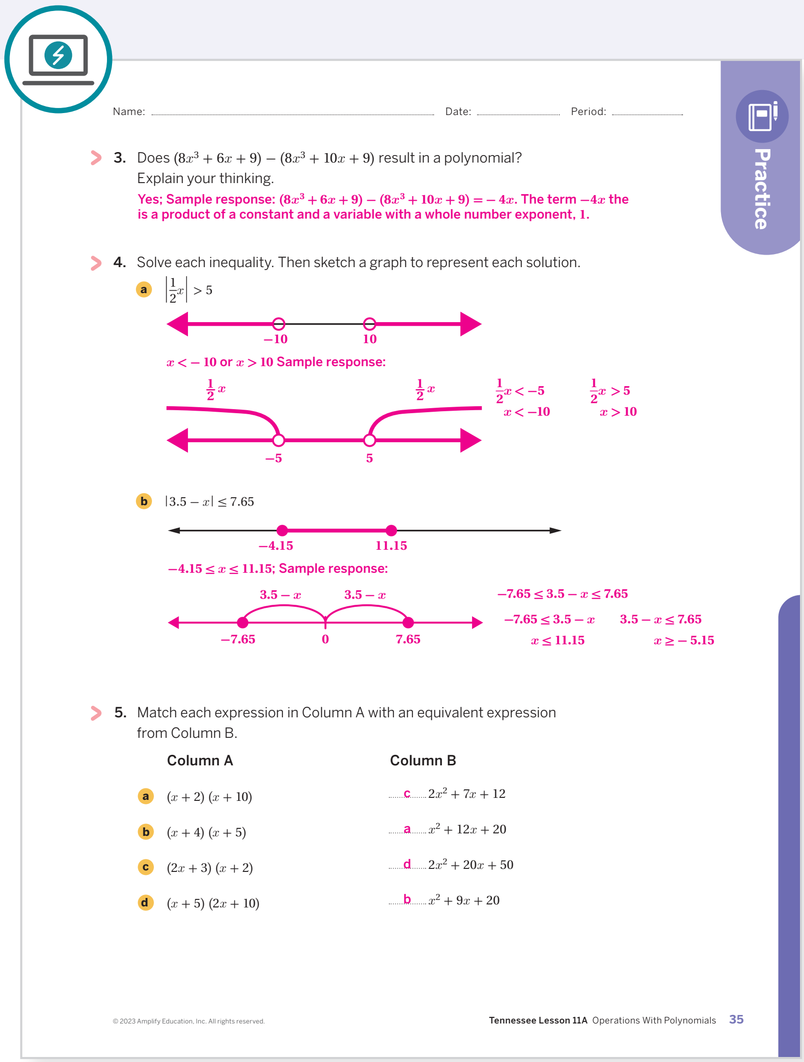

Name: Date: Period:

Practice

3. Does $(8x^3 + 6x + 9) - (8x^3 + 10x + 9)$ result in a polynomial? Explain your thinking.

Yes; Sample response: $(8x^3 + 6x + 9) - (8x^3 + 10x + 9) = -4x$. The term $-4x$ the is a product of a constant and a variable with a whole number exponent, 1.

4. Solve each inequality. Then sketch a graph to represent each solution.

a $\left|\frac{1}{2}x\right| > 5$

$x < -10$ or $x > 10$ Sample response:

$\frac{1}{2}x < -5$

$x < -10$

$\frac{1}{2}x > 5$

$x > 10$

b $|3.5 - x| \leq 7.65$

$-4.15 \leq x \leq 11.15$; Sample response:

$-7.65 \leq 3.5 - x \leq 7.65$

$-7.65 \leq 3.5 - x$

$x \leq 11.15$

$3.5 - x \leq 7.65$

$x \geq -5.15$

5. Match each expression in Column A with an equivalent expression from Column B.

Column A	Column B
a $(x + 2)(x + 10)$	c $2x^2 + 7x + 12$
b $(x + 4)(x + 5)$	a $x^2 + 12x + 20$
c $(2x + 3)(x + 2)$	d $2x^2 + 20x + 50$
d $(x + 5)(2x + 10)$	b $x^2 + 9x + 20$

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Tennessee Lesson 11A Operations With Polynomials 35

Practice Problem Analysis

Type	Problem	Refer to	Standard(s)	DOK
On-lesson	1	Activity 1	A1.A.APR.A.1	2
	2	Activity 2	A1.A.APR.A.1	2
	3	Activity 3	A1.A.APR.A.1	2
Spiral	4	Unit 1 Tennessee Lesson 12C	A1.A.REI.B.2b	2
Formative	5	Unit 5 Lesson 12	A1.A.APR.A.1	2

Power-up: If students need additional support with the key prerequisite concept or skill this problem addresses, consider assigning the Power-up in the next lesson.

Additional Practice Available

For students who need additional practice in this lesson, assign the **Algebra 1 Additional Practice.**

Solving Quadratic Inequalities

Let's solve quadratic inequalities using the graphs of the related quadratic equations.

Focus

Goal

1. Use related quadratic equations to determine solutions to quadratic inequalities.

Coherence

Today

Students build on their understanding of quadratic equations to develop strategies to solve quadratic inequalities. They make sense of problems and model with mathematics as they solve problems in context **(MP4)**.

Previously

In Unit 5, students explored the characteristics of graphs of quadratic functions. In prior lessons in Unit 6, students wrote and solved quadratic equations using the Zero Product Principle and by completing the square.

Coming Soon

In Lesson 16, students will solve quadratic equations with irrational solutions.

Rigor

- Students build a **conceptual understanding** of quadratic inequalities.
- Students develop **procedural skills** as they determine solutions to quadratic inequalities.
- Students **apply** their understanding of solving quadratic inequalities.

Standards

Addressing

A1.A.REI.B.3b
Solve quadratic inequalities using the graph of the related quadratic equation.

Also Addressing: **A1.A.REI.B.3a**

Pacing Guide

Suggested Total Lesson Time ~**50 min**

Warm-up	Activity 1	Activity 2	Activity 3	Summary	Exit Ticket
5 min	10 min	15 min	10 min	5 min	5 min
Independent	Pairs	Pairs	Pairs	Whole Class	Independent
	MP2		MP4		
A1.A.REI.B.3b	A1.A.REI.B.3b	A1.A.REI.B.3b, A1.A.REI.B.3a	A1.A.REI.B.3b	A1.A.REI.B.3b	A1.A.REI.B.3b

Amps powered by desmos | **Activity and Presentation Slides**

For a digitally interactive experience of this lesson, log in to Amplify Math at **learning.amplify.com**.

Practice

Independent

Materials

- Exit Ticket
- Additional Practice
- Activity 3 PDF (as needed)
- Anchor Chart PDF, *Sentence Stems, Explaining My Steps* (for display)
- colored pencils (as needed)
- graph paper

Math Language Development

Review words

- *quadratic equation*
- *inequality*
- *Zero Product Principle*
- *zeros*

Amps | **Featured Activity**

Activity 1

Interactive Graph

Students interact with graphs of quadratic functions to determine whether a value is a solution to the related quadratic inequality.

Building Math Identity and Community

Connecting to Mathematical Practices

Students who are more confident with the mathematical topic of this lesson may be able to lead discussions within their groups in Activity 1 **(MP2)**. Remind students to "step up" if they have something to add to the conversation, but also to "step back" to give other voices a chance to share.

Modifications to Pacing

You may want to consider these additional modifications if you are short on time.

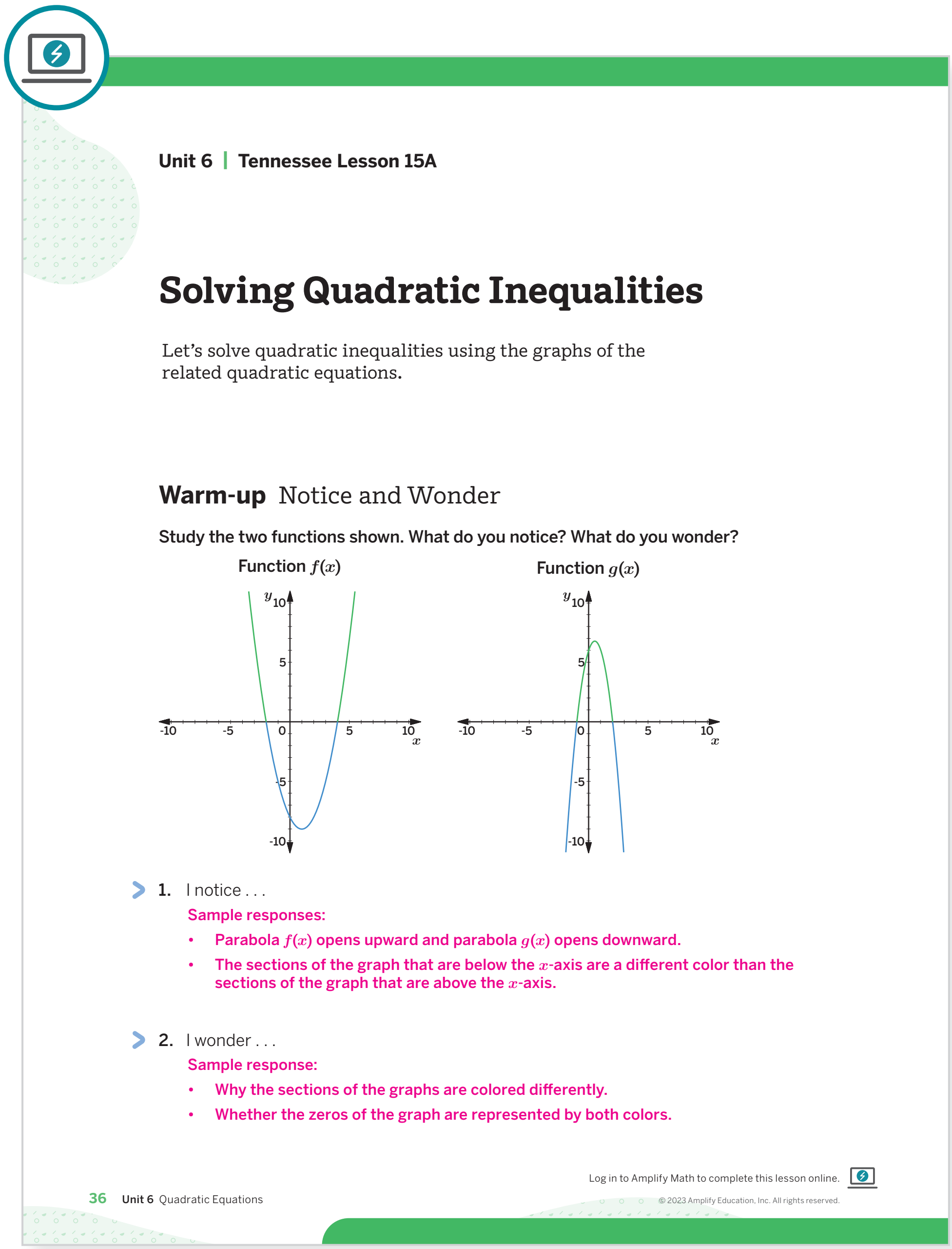
- In **Activity 1**, assign pairs of students to complete either Problem 1 or Problem 2.
- In **Activity 2**, Problems 3 and 4 may be omitted.
- **Activity 3** may be assigned as additional practice.

Independent | 5 min

Warm-up Notice and Wonder

A1.A.REI.B.3b

Students examine two functions to help visualize when a function is greater than zero and less than zero.



Unit 6 | **Tennessee Lesson 15A**

Solving Quadratic Inequalities

Let's solve quadratic inequalities using the graphs of the related quadratic equations.

Warm-up Notice and Wonder

Study the two functions shown. What do you notice? What do you wonder?

1. I notice . . .

   Sample responses:
   - Parabola $f(x)$ opens upward and parabola $g(x)$ opens downward.
   - The sections of the graph that are below the x-axis are a different color than the sections of the graph that are above the x-axis.

2. I wonder . . .

   Sample response:
   - Why the sections of the graphs are colored differently.
   - Whether the zeros of the graph are represented by both colors.

36 **Unit 6** Quadratic Equations

Log in to Amplify Math to complete this lesson online.

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1 Launch

Conduct the ***Notice and Wonder*** routine.

2 Monitor

Help students get started by asking them to examine how the parts of the graph are colored.

Look for productive strategies:

- Noticing that the graph of function $f(x)$ opens upward and the graph of function $g(x)$ opens downward.
- Noticing that the color of the graph changes before or after the zeros of the graph.
- Remembering that the coefficient of a in ax^2 for $f(x)$ is positive, and the coefficient of a in ax^2 for $g(x)$ is negative.

3 Connect

Display the graphs of the functions $f(x)$ and $g(x)$.

Have students share their responses. Select students with varying responses.

Ask:

- "Does the graph of function $f(x)$/function $g(x)$ open upward or downard? What does that tell you about the sign of a when the equation is written in standard form?"
- "What are the zeros of function $f(x)$/function $g(x)$?"

Highlight that function $f(x)$ and function $g(x)$ are quadratic functions. Tell students that they will explore how to solve quadratic inequalities using the related quadratic function. Tell students that the sections of the graph colored in blue are when the function $f(x)$ and the function $g(x)$ are greater than 0. The sections of the graph colored in orange are when the function $f(x)$ and the function $g(x)$ are less than 0.

Power-up

To power up students' ability to approximate irrational numbers, have students complete:

Determine whether the statement is *true* or *false*.

1. $4 < \sqrt{25} < 6$ True
2. $\sqrt{4} < 5 < \sqrt{6}$ False
3. $\sqrt{24} < \sqrt{25} < \sqrt{26}$ True

Use: Before the Warm-up

Informed by: Performance on Lesson 15, Practice Problem 6

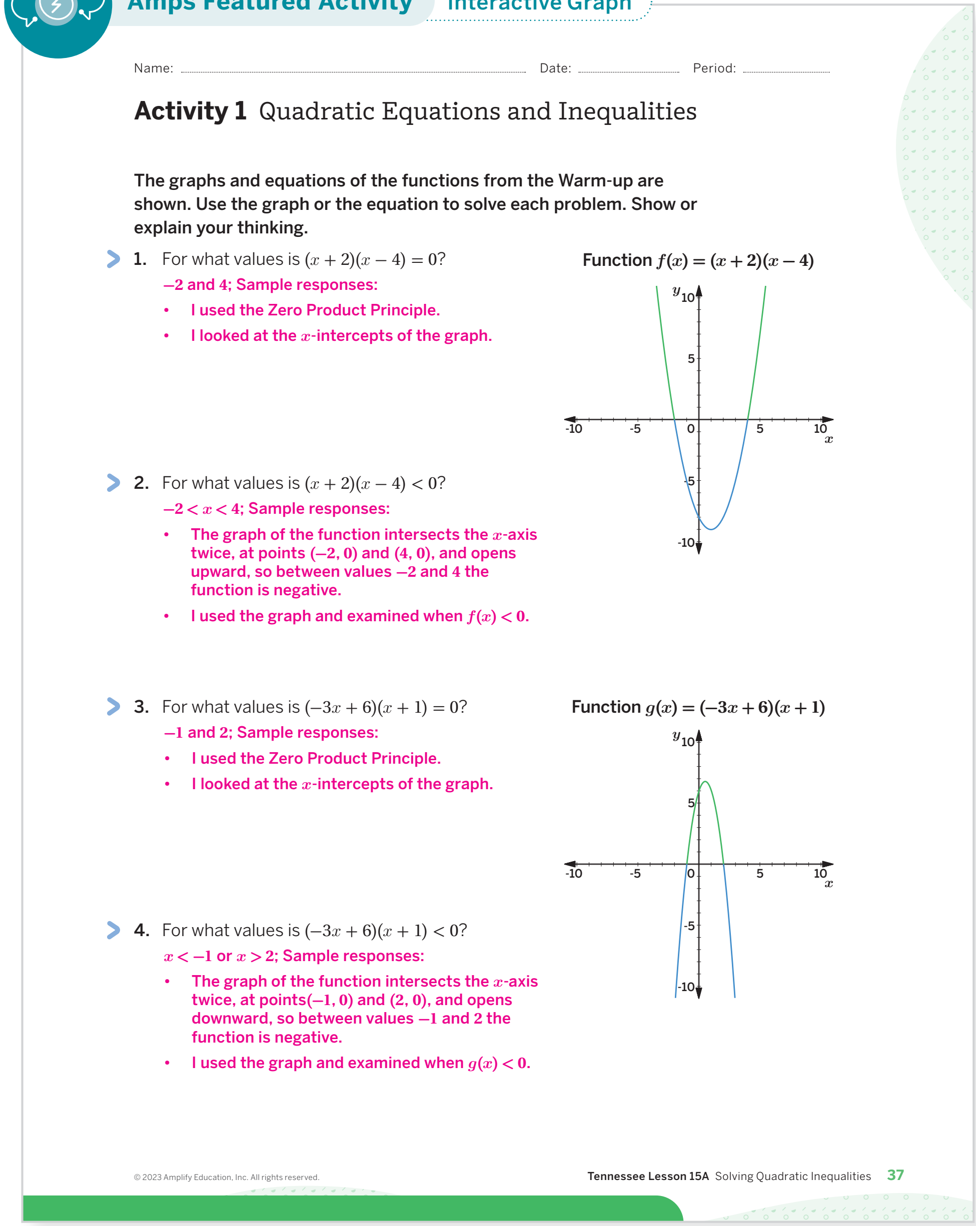
Pairs | 10 min

MP2
A1.A.REI.B.3b

Activity 1 Quadratic Equations and Inequalities

Students analyze graphs of quadratic functions to develop strategies for solving a related quadratic inequality.

Amps Featured Activity Interactive Graph



Name: Date: Period:

Activity 1 Quadratic Equations and Inequalities

The graphs and equations of the functions from the Warm-up are shown. Use the graph or the equation to solve each problem. Show or explain your thinking.

1. For what values is $(x + 2)(x - 4) = 0$?
   -2 and 4; Sample responses:
   - **I used the Zero Product Principle.**
   - **I looked at the x-intercepts of the graph.**

Function $f(x) = (x + 2)(x - 4)$

2. For what values is $(x + 2)(x - 4) < 0$?
   $-2 < x < 4$; Sample responses:
   - **The graph of the function intersects the x-axis twice, at points $(-2, 0)$ and $(4, 0)$, and opens upward, so between values -2 and 4 the function is negative.**
   - **I used the graph and examined when $f(x) < 0$.**

3. For what values is $(-3x + 6)(x + 1) = 0$?
   -1 and 2; Sample responses:
   - **I used the Zero Product Principle.**
   - **I looked at the x-intercepts of the graph.**

Function $g(x) = (-3x + 6)(x + 1)$

4. For what values is $(-3x + 6)(x + 1) < 0$?
   $x < -1$ or $x > 2$; Sample responses:
   - **The graph of the function intersects the x-axis twice, at points$(-1, 0)$ and $(2, 0)$, and opens downward, so between values -1 and 2 the function is negative.**
   - **I used the graph and examined when $g(x) < 0$.**

Tennessee Lesson 15A Solving Quadratic Inequalities 37

1 Launch

Activate students' prior knowledge of inequalities. Tell students that a quadratic inequality is similar to a quadratic equation, but uses an inequality sign, instead of an equal sign.

2 Monitor

Help students get started by reminding them how to solve a quadratic equation using the Zero Product Principle.

Look for points of confusion:

- **Struggling with Problem 2 or 4.** Have students trace the part of the graph where the function is negative. Ask them to identify a few values in which the function is negative, then identify all the values that are negative.
- **Writing only a few values for the solutions to Problems 2 or 4.** Ask students to identify additional values for which the inequalities are less than 0. Allow for this response and revisit these students during the Connect.

Look for productive strategies:

- Solving each equation or inequality algebraically or graphically.

3 Connect

Have students share their strategies for solving Problems 2 and 4. Select students who used the direction in which the parabola opens to help them determine their response **(MP2)**.

Ask, "What features of the graph were helpful when determining when the function was negative?"

Highlight

- Students can use the zeros of the function, and the direction in which the parabola opens to solve a quadratic inequality.
- How to write the solution using inequality symbols.

Differentiated Support

Accessibility: *Vary Demands to Optimize Challenge*

If students need more processing time, have them focus on completing Problem 1 and only work on Problem 2 if they have time available.

Accessibility: *Optimize Access to Technology*

Have students use the Amps slides for this activity, in which they can interact with graphs of quadratic functions to determine whether a value is a solution to the related quadratic inequality.

Math Language Development

MLR7: Compare and Connect

During the Connect, ask students to articulate the connection between the solutions to the equation $(x + 2)(x - 4) = 0$ and the inequality $(x + 2)(x - 4) < 0$. Invite students to compare how the zeros of the graph are used to determine each solution.

English Learners

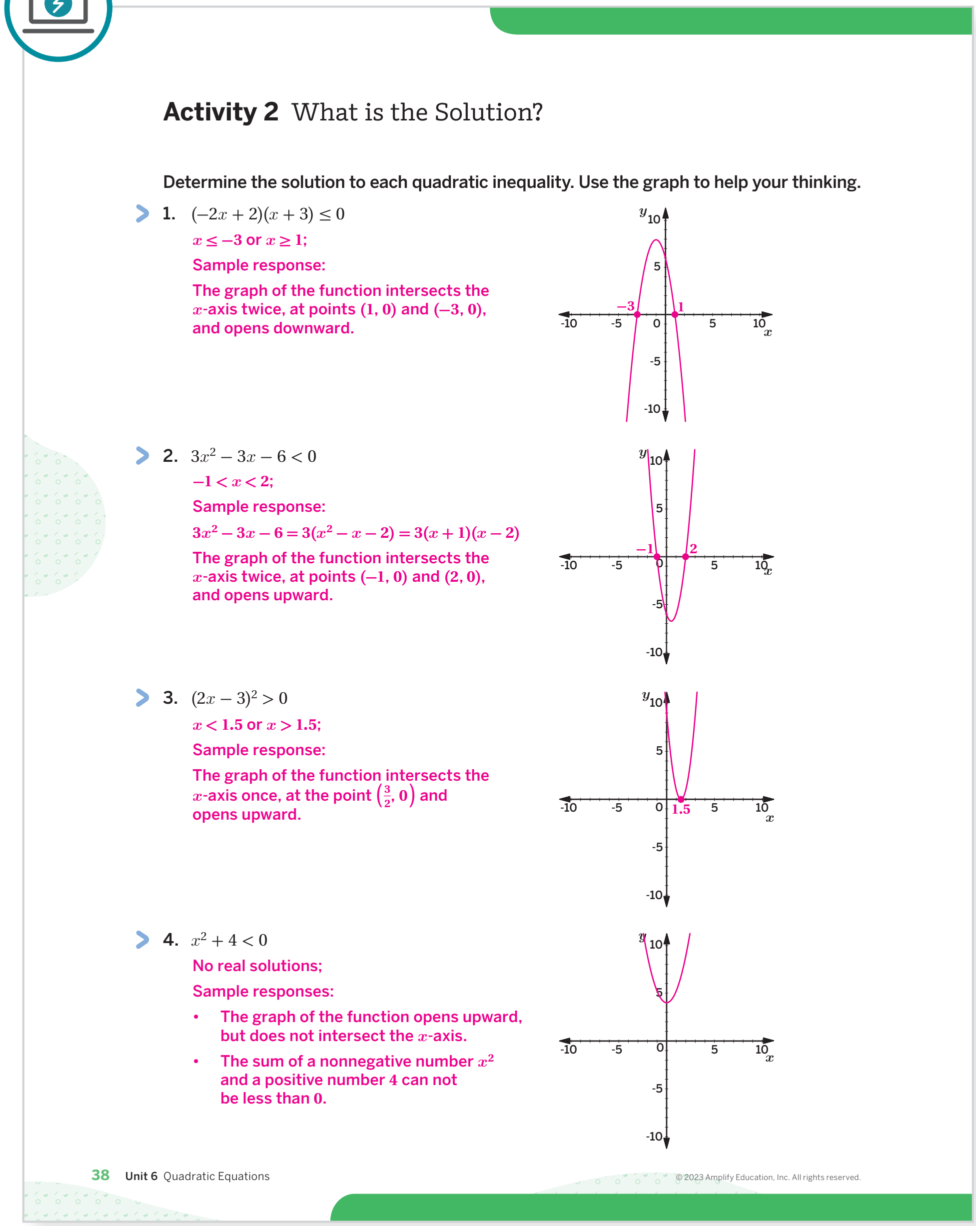
Annotate the zeros of the graph.

Pairs | 15 min

Activity 2 What is the Solution?

A1.A.REI.B.3b, A1.A.REI.B.3a

Students develop procedural skills as they determine the solutions to quadratic inequalities.



Activity 2 What is the Solution?

Determine the solution to each quadratic inequality. Use the graph to help your thinking.

1. $(-2x+2)(x+3) \leq 0$

   $x \leq -3$ or $x \geq 1$;

   Sample response:

   The graph of the function intersects the x-axis twice, at points $(1, 0)$ and $(-3, 0)$, and opens downward.

2. $3x^2 - 3x - 6 < 0$

   $-1 < x < 2$;

   Sample response:

   $3x^2 - 3x - 6 = 3(x^2 - x - 2) = 3(x+1)(x-2)$

   The graph of the function intersects the x-axis twice, at points $(-1, 0)$ and $(2, 0)$, and opens upward.

3. $(2x-3)^2 > 0$

   $x < 1.5$ or $x > 1.5$;

   Sample response:

   The graph of the function intersects the x-axis once, at the point $\left(\frac{3}{2}, 0\right)$ and opens upward.

4. $x^2 + 4 < 0$

   No real solutions;

   Sample responses:

   - The graph of the function opens upward, but does not intersect the x-axis.
   - The sum of a nonnegative number x^2 and a positive number 4 can not be less than 0.

1 Launch

Review each of the inequalities. Draw students' attention to each inequality symbol and the way each quadratic inequality is written.

2 Monitor

Help students get started by having them sketch the graph by identifying the zeros and determining whether the graph opens upward or downward.

Look for points of confusion:

- **Graphing the function in detail.** Tell students they do not need to identify the minimum/maximum in this situation. Instead, allow them to sketch the graph using the zeros and direction the parabola opens.
- **Forgetting to include the zeros for Problem 1.** Remind students that the ≤ symbol means that it will include the zeros.
- **Struggling to solve Problem 2.** Have students write the inequality in factored form before sketching the graph.
- **Struggling to solve Problem 4.** Encourage students to reason about the inequality. Ask, "Can four more than a non negative number, x^2 result in a negative number?"

3 Connect

Have students share their strategies for solving each inequality. Select pairs of students with varying responses.

Highlight the different strategies that could be used to solve quadratic inequalities.

Ask, "How do you think the solution to Problem 3 would change if the sign was changed, $(2x-3)^2 \geq 0$?"

Differentiated Support

Accessibility: ***Vary Demands to Optimize Challenge, Guide Processing and Visualization***

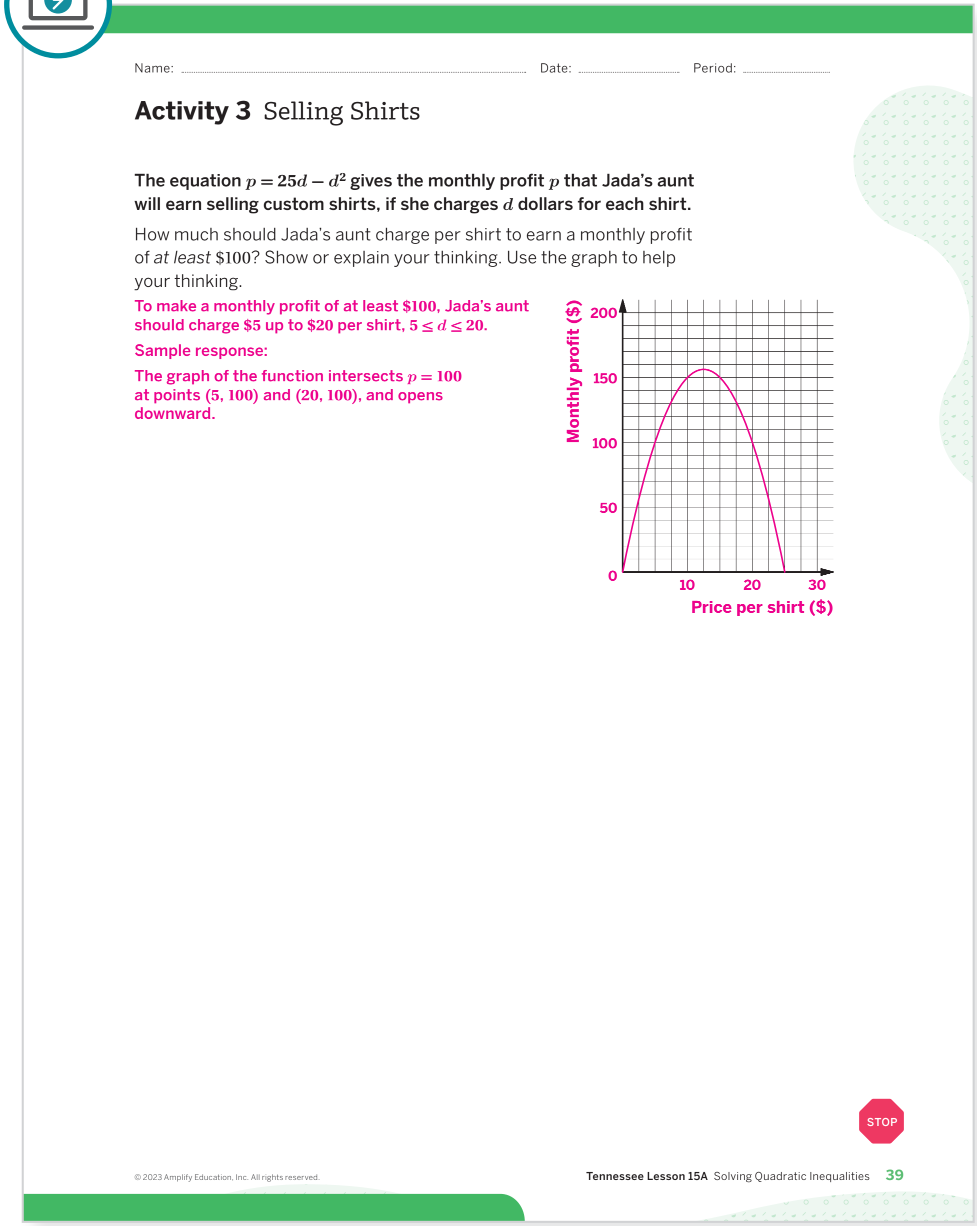
If students need more processing time, consider having them focus on Problems 1 and 2. Have students use colored pencils to indicate values on the graph that correspond with their solution.

Pairs | 10 min

Activity 3 Selling Shirts

MP4
A1.A.REI.B.3b

Students apply their understanding of the quadratic inequality by determining the amount that should be charged per shirt based on a monthly profit goal **(MP4).**



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Activity 3 Selling Shirts

The equation $p = 25d - d^2$ gives the monthly profit p that Jada's aunt will earn selling custom shirts, if she charges d dollars for each shirt.

How much should Jada's aunt charge per shirt to earn a monthly profit of *at least* $\$100$? Show or explain your thinking. Use the graph to help your thinking.

To make a monthly profit of at least $\$100$, Jada's aunt should charge $\$5$ up to $\$20$ per shirt, $5 \le d \le 20$.

Sample response:

The graph of the function intersects $p = 100$ at points $(5, 100)$ and $(20, 100)$, and opens downward.

Tennessee Lesson 15A Solving Quadratic Inequalities 39

1 Launch

Read the prompt aloud. Answer any questions students may have. Provide students with graph paper.

2 Monitor

Help students get started by having them work individually to write an inequality that represents the scenario. Have them share their inequalities and discuss any discrepancies before completing the remainder of the problem.

Look for points of confusion:

- **Writing a correct inequality, but struggling to solve it.** Students may write $-d^2 + 25d - 100 > 0$, but struggle to factor $-d^2 + 25d - 100$ because of the negative coefficient of d^2. Provide students with the equivalent inequality $d^2 - 25d + 100 < 0$ and have them determine the solution algebraically or graphically. Note: Students will learn how to solve quadratic equations with a negative coefficient in Lesson 20.
- **Writing the symbols > or < in their inequality.** Remind students that *at least* $\$100$ includes $\$100$.

Look for productive strategies:

- Graphing $p = 25d - d^2$ or $p = -d^2 + 25d - 100$.

3 Connect

Have students share the strategies they used to determine their response. Select students with varying strategies.

Display, the Activity 3 PDF.

Highlight the values when $5 \le x \le 20$ on the graph. Tell students that these points represent the amount Jada's aunt should charge to make a monthly profit of at least $\$100$.

Differentiated Support

Accessibility: *Vary Demands to Optimize Challenge*

If students need more processing time, consider providing them with a copy of the Activity 3 PDF to help them make sense of the problem.

Math Language Development

MLR8: Discussions Supports

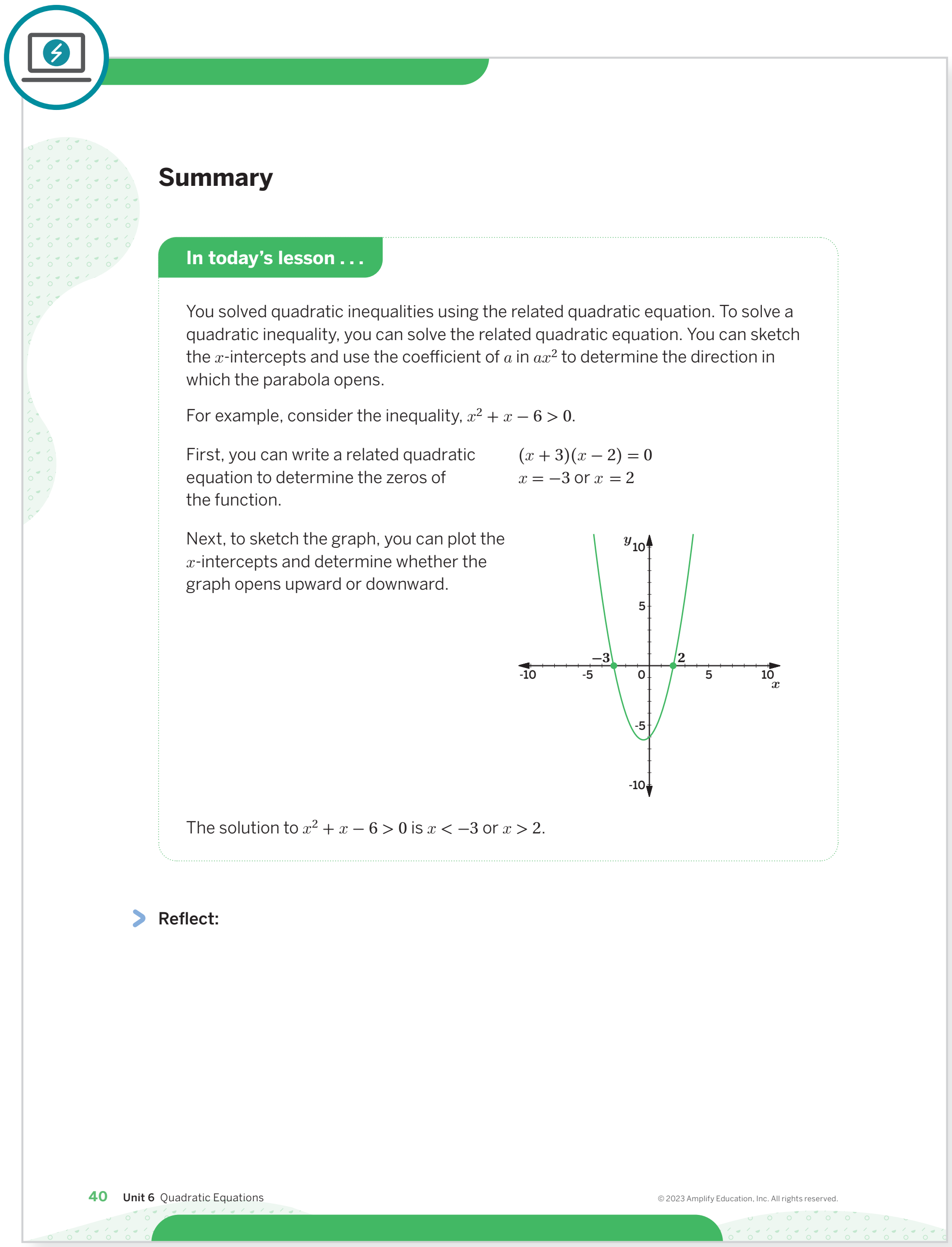
During the Connect, display the Anchor Chart PDF, *Sentence Stems*, *Explaining My Steps* for students to use to help them organize their thinking as they explain how they determined their response.

Whole Class | 5 min

Summary

A1.A.REI.B.3b

Review and synthesize solving quadratic inequalities.



Summary

In today's lesson . . .

You solved quadratic inequalities using the related quadratic equation. To solve a quadratic inequality, you can solve the related quadratic equation. You can sketch the x-intercepts and use the coefficient of a in ax^2 to determine the direction in which the parabola opens.

For example, consider the inequality, $x^2 + x - 6 > 0$.

First, you can write a related quadratic equation to determine the zeros of the function.

$(x + 3)(x - 2) = 0$
$x = -3$ or $x = 2$

Next, to sketch the graph, you can plot the x-intercepts and determine whether the graph opens upward or downward.

The solution to $x^2 + x - 6 > 0$ is $x < -3$ or $x > 2$.

Reflect:

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Synthesize

Ask, "What strategies did you find helpful when solving quadratic inequalities?"

Have students share which features of the graph they could use to help them determine solutions for a quadratic inequality.

Highlight that when solving quadratic inequalities, students can write a related quadratic equation to determine the zeros of the function. They can determine whether the graph opens upward or downward before sketching the graph and identifying which parts of the graph represent the solution to the inequality.

Reflect

After synthesizing the concepts of the lesson, allow students a few moments for reflection. Encourage them to record any notes in the *Reflect* space provided in the Student Edition. To help them engage in meaningful reflection, consider asking:

- "What is similar about solving quadratic inequalities and linear equalities? What is different?"

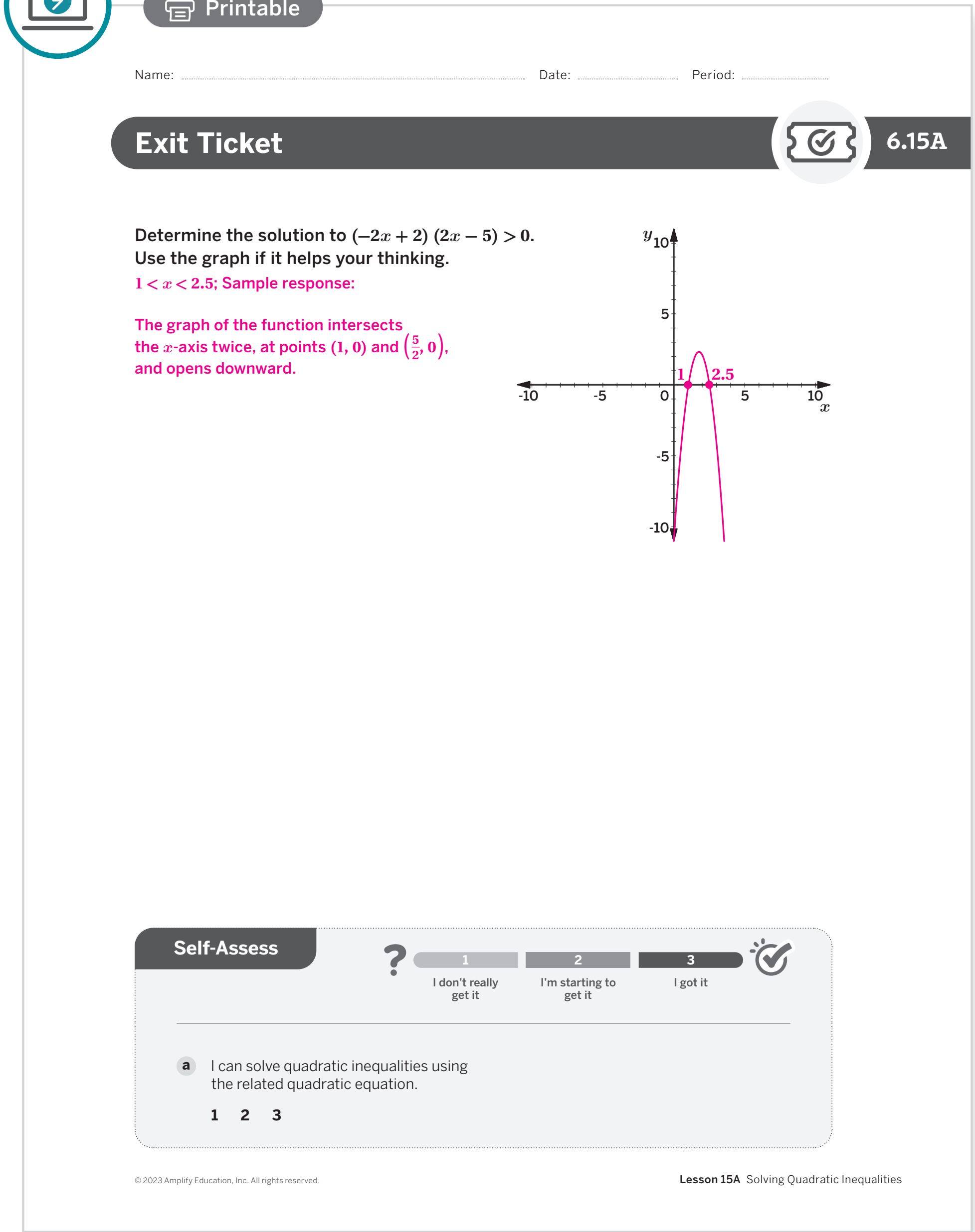
Independent | 5 min

Exit Ticket

A1.A.REI.B.3b

Students demonstrate their understanding by determining the solution to a quadratic inequality.

Printable



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Exit Ticket

6.15A

Determine the solution to $(-2x + 2)\ (2x - 5) > 0$. Use the graph if it helps your thinking.

$1 < x < 2.5$; Sample response:

The graph of the function intersects the x-axis twice, at points $(1, 0)$ and $\left(\frac{5}{2}, 0\right)$, and opens downward.

Self-Assess

? 1	2	3
I don’t really get it	I’m starting to get it	I got it

a I can solve quadratic inequalities using the related quadratic equation.

1 2 3

Success looks like . . .

- **Goal:** Using related quadratic equations to determine solutions to quadratic inequalities.
    - » Graphing a related quadratic equation.
    - » Determining the solution to a related quadratic equation to help determine the solution to the inequality.

Suggested next steps

If students correctly write and solve a related quadratic equation, but provide an incorrect solution to the inequality, consider:

- Having them graph the related quadratic equation to help them visualize the solution.
- Reviewing inequality symbols.

If students do not write a related quadratic equation and provide an incorrect solution, consider:

- Reviewing the Zero Product Principle.

Professional Learning

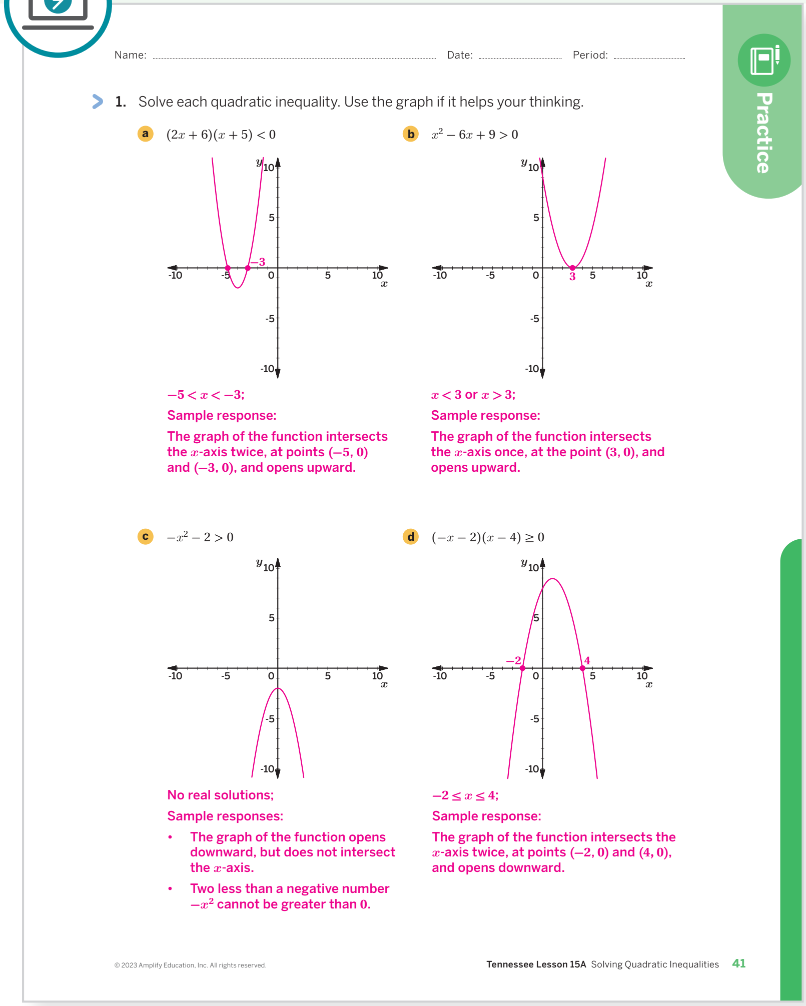
This professional learning moment is designed to be completed independently or collaboratively with your fellow mathematics educators. Prompts are provided so that you can reflect on this lesson before moving on to the next lesson.

Points to Ponder . . .

- What worked and didn’t work today? In this lesson, students solved quadratic inequalities. How did that build on the earlier work students did with solving quadratic equations?
- What challenges did students encounter as they worked on Activity 3? How did they work through them? What might you change for the next time you teach this lesson?

Practice

Independent



Name: Date: Period:

Practice

1. Solve each quadratic inequality. Use the graph if it helps your thinking.

a $(2x + 6)(x + 5) < 0$

$-5 < x < -3$;

Sample response:

The graph of the function intersects the x-axis twice, at points (–5, 0) and (–3, 0), and opens upward.

b $x^2 - 6x + 9 > 0$

$x < 3$ or $x > 3$;

Sample response:

The graph of the function intersects the x-axis once, at the point (3, 0), and opens upward.

c $-x^2 - 2 > 0$

No real solutions;

Sample responses:

- The graph of the function opens downward, but does not intersect the x-axis.
- Two less than a negative number $-x^2$ cannot be greater than 0.

d $(-x - 2)(x - 4) \geq 0$

$-2 \leq x \leq 4$;

Sample response:

The graph of the function intersects the x-axis twice, at points (–2, 0) and (4, 0), and opens downward.

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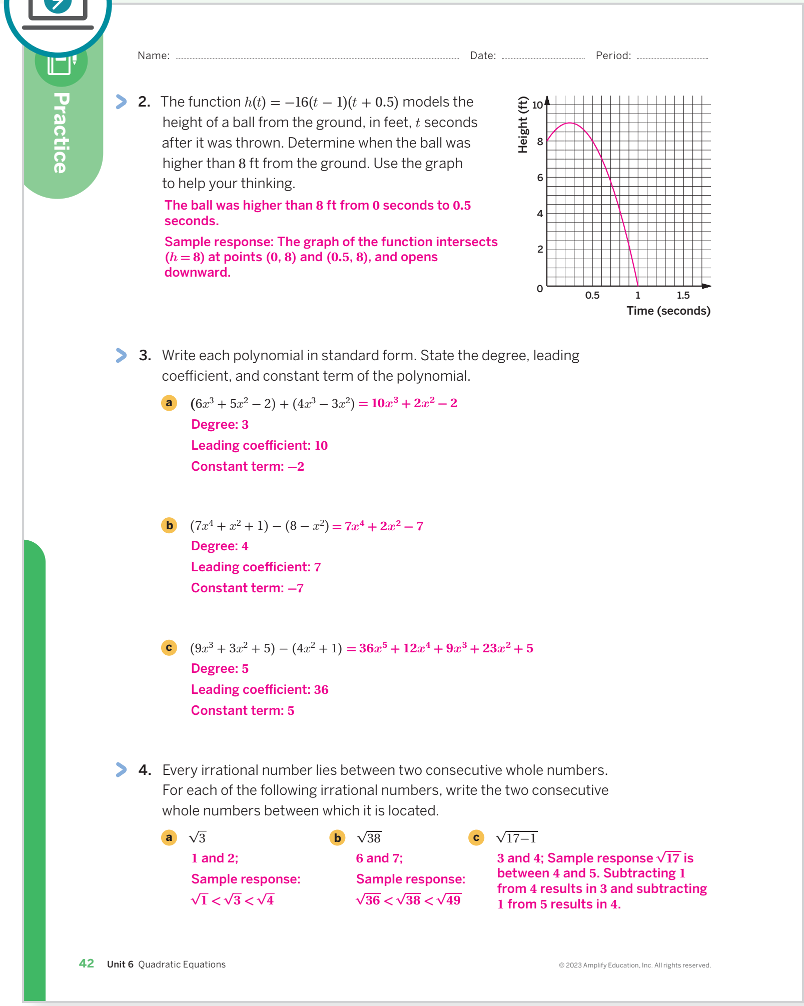

Name: Date: Period:

Practice

2. The function $h(t) = -16(t - 1)(t + 0.5)$ models the height of a ball from the ground, in feet, t seconds after it was thrown. Determine when the ball was higher than 8 ft from the ground. Use the graph to help your thinking.

The ball was higher than 8 ft from 0 seconds to 0.5 seconds.

Sample response: The graph of the function intersects ($h = 8$) at points (0, 8) and (0.5, 8), and opens downward.

3. Write each polynomial in standard form. State the degree, leading coefficient, and constant term of the polynomial.

a $(6x^3 + 5x^2 - 2) + (4x^3 - 3x^2) = 10x^3 + 2x^2 - 2$

Degree: 3

Leading coefficient: 10

Constant term: –2

b $(7x^4 + x^2 + 1) - (8 - x^2) = 7x^4 + 2x^2 - 7$

Degree: 4

Leading coefficient: 7

Constant term: –7

c $(9x^3 + 3x^2 + 5) - (4x^2 + 1) = 36x^5 + 12x^4 + 9x^3 + 23x^2 + 5$

Degree: 5

Leading coefficient: 36

Constant term: 5

4. Every irrational number lies between two consecutive whole numbers. For each of the following irrational numbers, write the two consecutive whole numbers between which it is located.

a $\sqrt{3}$

1 and 2;

Sample response:

$\sqrt{1} < \sqrt{3} < \sqrt{4}$

b $\sqrt{38}$

6 and 7;

Sample response:

$\sqrt{36} < \sqrt{38} < \sqrt{49}$

c $\sqrt{17-1}$

3 and 4; Sample response $\sqrt{17}$ is between 4 and 5. Subtracting 1 from 4 results in 3 and subtracting 1 from 5 results in 4.

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Practice Problem Analysis

Type	Problem	Refer to	Standard(s)	DOK
On-lesson	1	Activity 2	A1.A.REI.B.3b	2
	2	Activity 3	A1.A.REI.B.3b	3
Spiral	3	Unit 5 Tennessee Lesson 11A	A1.A.APR.A.1	2
Formative ⚡	4	Unit 6 Lesson 16	8.NS.A.2	2

⚡ **Power-up:** If students need additional support with the key prerequisite concept or skill this problem addresses, consider assigning the Power-up in the next lesson.

Additional Practice Available

For students who need additional practice in this lesson, assign the **Algebra 1 Additional Practice**.